A SCIENTIFIC INVESTIGATION INTO VEGETARIANISM

Mr. EUSTACE MILES, M.A.

THE GREAT FOOD EXPERT

(Formerly Scholar of King's College, Cambridge, Honours Coach and Lecturer at Cambridge and Girton, and Amateur Champion of the World at Racquets and Tennis)

HAS advised tens of thousands of people successfully about their

Diet for Cure and Health.

Do not give up meat and eat the rest.
Get a scientific diet.

If you write to Mr. EUSTACE MILES at 40, CHANDOS STREET, LONDON, W.C.2, he will send you a list of twelve well-tested, economical, one-course MEALS.

DELICIOUS, DIGESTIVE, SUSTAINING.

Mention your average day's foods and drinks and any ailments, and Mr. MILES will gladly give you a little

FREE ADVICE

ABOUT CURE AND HEALTH.

When you are in London, have the wonderful

1s. 3d. Three-Course

Popular Table d'Hôte,

At the EUSTACE MILES RESTAURANT,
40, CHANDOS STREET, CHARING CROSS.

Always instead of meat,

Use "EMPROTE"

The best Food basis and staple. It is ready for use without cooking. Its value is endorsed by General BRUCE (of Mount Everest fame), F. DAVEY (the famous record-breaking cyclist) and thousands of others.

WHEN IN THE CITY
YOU SHOULD
LUNCH, DINE OR TAKE TEA

AT THE

FOOD REFORM RESTAURANT.

1, 2 & 3, FURNIVAL ST., HOLBORN, E.C.
(Near Gray's Inn Road, next to Roneo's).

A MODERN BUILDING, COMPLETE IN EVERY DETAIL, WITH AMPLE ACCOMMODATION FOR 400 DINERS.

A Good Selection of Cooked Dishes
SALADS, FRUITS and NUTS.

OPEN TO 7.30. *SATURDAYS 2.30.*

ROOMS TO LET FOR SOCIALS, MEETINGS, Etc.

JOHN BALE, SONS & DANIELSSON, LTD.

Two new books of great interest.

REJUVENATION

By Dr. JEAN FRUMUSAN. With a Preface by JEAN FINOT. The Duty, the Possibility, and the Means of Regaining Youth. Translated from the French by ELAINE A. WOOD.
Cr. 8vo. 7s. 6d. net. [*Seventh Edition.*

"All who wish to live a long life . . . should read 'Rejuvenation,' a remarkable book . . . packed full of common sense."—*Daily Mail.*

A GREEN OLD AGE

By Prof. A. LACASSAGNE. Translated from the 2nd French Edition by HERBERT WILSON. With 17 plates.
Demy 8vo. 15s. net.

"Prof. Lacassagne's book on the subject of old age is one of the best which we have seen."—*Lancet.*

83-91, GREAT TITCHFIELD STREET, LONDON, W. 1.
Face title page.

MPAY
L

A Scientific Investigation into Vegetarianism

BY

JULES LEFÈVRE

Chevalier de la Légion d'Honneur.
Lauréat de l'Institut et de la Société de Biologie.
Professeur au Lycée Pasteur.

AUTHORIZED TRANSLATION BY FRED ROTHWELL.

J 96234
24.5.35

LONDON :
JOHN BALE, SONS & DANIELSSON, LTD.,
OXFORD HOUSE,
83-91, GREAT TITCHFIELD STREET, OXFORD STREET, W.1.

PRINTED AND MANUFACTURED IN GREAT BRITAIN.

TRANSLATOR'S NOTE.

Dr. Jules Lefèvre has been compelled to coin a new word "végétalien"—which I feel I too must render by a new word "vegetalian"—in order to make a very necessary distinction between the three principal varieties of a non-flesh dietary: the fruitarian, which is self-explanatory and quite unambiguous; the ordinary accepted vegetarian, which includes the use of the animal products—butter, cheese, milk and eggs; and that diet which includes vegetables and fruit but rejects all animal products whatsoever.

It is this latter diet for which it is now necessary to use the word "vegetalian," the lack of some such term having increasingly been felt for many years by food reformers. I here express the hope that it may be accorded a place, seeing that it is the only expression which has hitherto been suggested as applying exclusively to this special category midway between the fruitarian and the vegetarian regime.

Would that some linguistic genius would speedily supply us with a new word for the much abused and widely misunderstood term "vegetarian" itself!

Fred Rothwell.

Digitized by the Internet Archive
in 2007 with funding from
Microsoft Corporation

http://www.archive.org/details/scientificinvest00lefuoft

PREFACE.

UNDER pressure of the brute realities of the recent war, the minds of men have been compelled to adopt a wider outlook as regards diet. For the first time, many have had to break away from the shackles of flesh-eating prejudices and to consider the various substitutes for meat. In 1918, both at the École de Médecine and in the press, many encomiums were lavished on our quasi-official crusade in favour of a rational and a meatless diet. How many were converted by the demonstrations of the possibility of eating less flesh, and of the advantage of a vegetarian bill-of-fare?

As a matter of fact, vegetarianism constitutes a regime of health and strength which enables man throughout his life to utilize all his faculties to the full.

This light-bringing truth is also becoming increasingly manifest in official instruction. In his treatise on Diet, Armand Gautier stated in 1908 that vegetarianism should be practised "by all who pursue the ideal of building up and educating races intelligent and artistic, and at the same time prolific, vigorous and active."

May the reader become convinced of this truth as he reflects on the following pages, alike scientific and simple to understand. The advantage he will thereby gain will be a better recompense to us than any other could be.

J. L.

CONTENTS.

CHAPTER I.

PAGE

Vegetarianism and Statistics 1

CHAPTER II.

The Physiology of Diet and Vegetarian Doctrines ... 25

CHAPTER III.

Illness and a Food Regime 59

CHAPTER IV.

Food Regimes in Social and Economical Problems ... 86

CHAPTER V.

The Feeding of the Human Motor... 112

CHAPTER VI.

Animal Heat and a Cold-resistance Regime 165

INDEX 187

A SCIENTIFIC INVESTIGATION INTO VEGETARIANISM.

CHAPTER I.

VEGETARIANISM AND STATISTICS.

I.

Historical Bases—Present Trend and Development.

You may at one time or another have been present at a discussion on vegetarianism. Vegetarians, it is explained, are eccentric or mad, unpleasant and even dangerous to have dealings with. Born with a mania for contradiction, animated by a spirit that is half reform and half revolutionary, they claim to dictate that man shall feed on herbs and roots like a savage. Knowing little of the benefits of our progressive modern civilization, forgetful or ignorant of the data of science, they are determined to force upon us a painful asceticism by means of a diet that is repulsive, scarcely good enough for beasts of burden! Luckily the mad creatures are brought up against the good sense of the people and encounter only ironical smiles instead of a rich harvest of converts to a diet fit for cows and horses . . . . . Hay and oats, what madness!

When your turn came, you insisted on the im-

possibility of doing without meat. Every time I leave out meat from my usual meal, I feel quite faint. Nor am I an exception. Look at Mrs. X . . . . . who is known to enjoy perfect health; she gave up long ago all thought of fasting or leaving out meat from her meals, in spite of a keen desire to comply with her religious scruples. *A fortiori*, what would become of sufferers from anæmia and neurasthenia like ourselves, were we to be deprived of meat, the healthiest and most indispensable of all the foods lavished upon us by a kind Providence?

You are quite right, you have been told; we must respect the designs of Providence and remember that God created animals in order that they might be eaten. Otherwise, of what use would they be? . . . . . What would become of them? . . . . . Besides, it must not be forgotten that vegetarianism, by ruining the trade of the butchers, would actually bring about a social revolution!

Decidedly, from whatever point of view such a system of life be regarded, it is dangerous and absurd! . . . . .

And with such sage remarks, the conversation has ended. Vegetarianism had been tried in the balance and found wanting.

Well, may I be permitted to continue this conversation and tell you from the very start that you are mistaken, that you have largely deceived yourself, and that your opinion of vegetarianism is erroneous? Having studied it at close quarters, I intend to replace Truth on her pedestal and will supply exact information regarding vegetarianism and vegetarians to such as are willing to glean their information from other than frivolous and worldly sources. My object is also to enable them to see that there *is* a vegetarian movement; that vegetarianism, old as the hills, has been advocated by the

greatest of mankind, that it did not spring from the imagination of a diseased brain but does actually respond to scientific reality. In a word, I mean to prove that it is taught by general biology, by anatomy and physiology, physics and chemistry, that the social problem demands it and that common sense proves it to be right.

The subject is a vast one. In this first chapter, therefore, we will go swiftly over the historical bases of vegetarianism, laying emphasis on the accelerated rate of progress it has made in these modern times.

II.

Brief Historical Sketch of Vegetarianism.

From the most distant antiquity, moralists, law-givers, leaders of science, philosophy and religion, have thundered against excesses in diet, advocating total abstinence from animal flesh on the part of their contemporaries, their disciples and followers.

Without going back to the times of the magi, of the sages of India, China and ancient Egypt, a period when vegetarianism was held in great honour—we may remember that, among the Jews, the Nazarenes practised complete abstinence from flesh.

The Pelasgians lived on fruit; Triptolemus said in his original law: "Learn that the flesh of animals was never given to you for food."

The Pythagoreans are known to have lived on figs, cheese and vegetables, varied with honey and bread. Pythagoras, who lived over a hundred years, in speaking of flesh, said: "Forbear, O mortals, to pollute your bodies with so abominable a food."

Plato tolerates the use of meat for the soldier only; he forbids it to the citizens of his ideal

Republic: "Their food,' he says, "shall be of barley and wheat flour wherewith they shall make bread and beautiful cakes. They shall also have salt, olives, cheese, onions and other vegetables which can be cooked. I would not even deprive them of dessert: they shall have figs, peas, beans. Thus, tranquil and healthy, they will attain to old age and leave their children the heritage of a happy life." Very frugal himself, Plato lived mainly on figs.

The Neo-Platonists of the School of Alexandria: Longinus, Iamblichus, Porphyry followed out the precepts of the Master. In a lengthy work on abstinence from animal flesh, Porphyry strongly expresses his horror of meat: "Even though all the wolves and vultures in the world approved of the practice, we would still refuse to acknowledge that it was a just and right thing."

The same ideas were expressed by other sages. Chrysippus and Sextus suggested them to Seneca, who was a partisan of the vegetable regime.

The eloquent discourse of Plutarch against the use of flesh food contains the four following conclusions:—

(1) There is nothing more natural than the reluctance one feels against eating the flesh of animals;

(2) Cruel necessity alone could have compelled the first man to do it;

(3) There is ingratitude, barbarity and unrestrained sensuality in eating flesh;

(4) The human being has not the physical constitution of a carnivorous animal.

The famous moralist and historian adds: "You speak of savage dragons, of panthers and lions, and yet you yourselves are in no way behind these animals in cruelty; to them murder supplies food,

whereas your object is a feast, and even so you have to use artifice to disguise the horror of it."

Ovid made a strictly vegetarian profession of faith which he placed in the mouth of Pythagoras himself. After having stigmatized the murder of animals, he says:—

"But they of ancient times, justly called the Age of Gold, content with the fruit of their trees and the herbs of earth, stained not their lips with blood . . . .

Refrain, I beseech you! Give heed to my precepts! And when you would feast on the limbs of the dismembered ox, know and reflect that it is the tiller of your fields you would destroy! . . . .

Make war on noxious creatures, and kill them only. But let your mouths be empty of blood, and satisfied with pure and natural repasts."

Metamorphoses, Book 15.

Everyone knows how vigorously the Fathers of the Church spoke against the use of meat. "We follow the example of wolves and tigers," exclaimed Chrysostom. "We are even worse than they, for God has honoured us with a capacity for justice and equity."[1]

Clement of Alexandria said: "Let us refrain from such food. Have we not a sufficiently great variety in fruit and milk and all sorts of dry aliments! Those who meet together round tables too plentifully laden with rich viands do but feed their own maladies, and develop one more shameful still which I will call the demon of gluttony."

It may naturally be objected that such teachings of antiquity are applicable neither to our colder climate nor to the greater intensity of our daily life.

[1] *Homilies*, Sermons XLVII and XLVIII.

We will therefore see what the moderns have to say.

But first, we must remember that the Catholic Church recommends abstinence and fasting to its members, and more especially to its priests, not only as a penance but also for the good both of soul and of body. Though it has regarded it necessary to make concessions to worldly usage and prejudice, still there are certain religious orders which have literally followed the original rule; these orders are the very ones whose adepts attain to a remarkable old age.

The celebrated Gassendi, who lived in the seventeenth century, was a convinced vegetarian. "It is true," he wrote to Van Helmont, the chemist, "that man feeds on meat; but how many things contrary to his nature does he not do every day! . . . . From the conformation of our teeth, it is clear that Nature did not intend us to eat meat. Carnivorous animals have long conical teeth, unequal and at a distance from one another, e.g., the lion, the wolf, the dog, &c. Those intended for a vegetable regime have short wide teeth, blunt and regular, e.g., the horse, the goat, the sheep. Our teeth belong to this latter category."

In his medical thesis, Gassendi undertook to prove that "flesh in no way forms part of the natural regime of man, and that animal food is extremely harmful to human beings."

John Ray, the learned English botanist, expresses himself as follows on the subject of the vegetable kingdom:—

"All that we need for food, all that ought to refresh us and give us pleasure, we may find in abundance in this inexhaustible store of Nature. How sweet, holy and innocent is the sight of a table thus spread; how different from a meal

composed of the smoking flesh of slaughtered and massacred animals! Of a surety, man is nowise endowed with the organization of a carnivorous being . . . To sum up, our gardens supply us with all imaginable delights, whereas the slaughter-house and the butcher's shop reek with congealed blood and an abominable stench."

The learned Bossuet does not hesitate to attribute the physical and moral decline of man to his blood-stained meals. "Before the time of the Deluge, the food which men took, without doing violence to any living being, represented by fruit ready to fall from the tree, was doubtless a relic of pristine innocence . . . In these present times, blood has to be shed for our nourishment, in spite of the natural horror it causes in us, and all the refinement we employ in dressing our tables barely disguises the corpses we have to eat to satisfy our appetite."

The excesses of carnivorous man could not elude the pen of Voltaire. In his *Lettres d'un Indien*, this genius of irony delights in showing up the worst side of European cooking; jestingly he dwells upon the nauseating odours given off by meat and fat.

Diderot and J. J. Rousseau are well known to have been resolute defenders of vegetarianism. The former asks himself if it is not encouraging men to deeds of cruelty when we permit them to plunge a knife into the throat of an animal. The author of *Emile* remarks that "peasant women eat less meat and more vegetables than town and city women; this vegetable regime would appear to be rather favourable than the contrary both to themselves and to their children." "When they are entrusted with a middle-class foster child to nurse," he adds, "they are given soup and boiled meat under the impression that better chyle and a more abundant flow of milk will be the result. This is by no means

my opinion ; experience has taught me that babes thus nourished are more liable than others to suffer from worms and colic. Is it possible that, the vegetable regime being acknowledged best for the child, an animal regime can be better for the nurse ? . . ."

Hardened flesh-eaters may now reflect upon the following lines of the poet Shelley :—

"Comparative anatomy teaches us that man resembles frugivorous animals in everything, and carnivorous in nothing ; he has neither claws wherewith to seize his prey, nor distinct and pointed teeth to tear the living fibre. A mandarin 'of the first class,' with nails 2 inches long, would probably find them alone inefficient to hold even a hare. After every subterfuge of gluttony, the bull must be degraded into the ox, and the ram into the wether, by an unnatural and inhuman operation, that the flaccid fibre may offer a fainter resistance to rebellious nature. It is only by softening and disguising dead flesh by culinary preparation that it is rendered susceptible of mastication or digestion ; and that the sight of its bloody juices and raw horror does not excite intolerable loathing and disgust . . .

"By all that is sacred in our hopes for the human race, I conjure those who love happiness and truth to give a fair trial to the vegetable system. Reasoning is surely superfluous on a subject whose merits an experience of six months would set for ever at rest. But it is only among the enlightened and benevolent that so great a sacrifice of appetite and prejudice can be expected, even though its ultimate excellence should not admit of dispute. It is found easier, by the short-sighted victims of disease, to palliate their torments by medicine than to prevent them by regimen." Shelley goes on to insist on the

enormous social and economical benefits to be derived from a reform of diet.

Admire also this fine passage of Michelet: "A profound revolution has taken place; we have abandoned the sober French regime and increasingly adopted the heavy blood-stained diet of our neighbours. Worst of all, we inflict it on our children. How strange to see a mother offer her daughter, to whom but a short time previously she gave the breast, a coarse diet of bleeding meat and such dangerous excitants as wine and coffee! . . . And yet she is astonished to find the girl violent, whimsical and passionate! It is herself she ought to accuse. What she does not yet see—a matter far more serious—is that in our precocious French race, the senses are directly stimulated by such a diet. Instead of strengthening, it disturbs, weakens and enervates. Both for the woman and for the child it is a favour, an act of love, to be essentially frugivorous, to avoid the fetid odour of meat, and live rather on innocent food which causes the death of no living thing and pleases smell and taste alike! . . ."

Lamartine, brought up by his mother on the principles of vegetarianism, relates that he lived only on bread, milk-food, vegetables and fruit up to the age of 12. "My health," he said, "was no less vigorous nor my growth less rapid as a result; it may be that I am indebted to this regime for the refinement of features, the exquisite sensitiveness of impressions and the serenely gentle temper and disposition which I retained up to that period."

Faithful to his mother's teaching, Lamartine wrote the following noble lines:

". . . Les hommes, pour apaiser leur faim,
N'ont pas assez des fruits que Dieu met sous leur main.
Par un crime envers Dieu, dont frémit la nature,
Ils demandent au sang une autre nourriture.
Dans leur cité fangeuse, il coule par ruisseaux !
Les cadavres y sont étalés en monceaux,
Ils trainent par les pieds, des fleurs de la prairie,
L'innocente brebis, que leur main a nourrie,
Et sous l'œil de l'agneau, l'égorgeant sans remord,
Ils savourent ses chairs et vivent de sa mort . . ."

"Thus," says Bonnejoy, "Ovid and Lamartine, two of the greatest poets in ancient and modern times, have sung in sublime verse the praises of a pure diet."

Nor must we forget that the greatest men of science also have upheld the vegetarian mode of life. In addition to Gassendi and Ray, we may also mention Pascal, Newton, Franklin and numerous others less renowned who were either vegetarians or in favour of the vegetarian doctrine.

The great Cuvier, the master of naturalists and creator of comparative anatomy, positively affirms that man is intended to live mainly on fruits, roots and the succulent parts of vegetables.

Examining the dentition of man and comparing it with that of the various animal species, Professor Milne-Edwards concludes that his organism is intended for an essentially vegetable regime.

A master of therapeutics, Dujardin-Beaumetz, exclaims: "Man in his origin must have been a vegetarian !"

Is it necessary to quote Drs. Huchard, Lucas-Championnière, Robin, Reiche, Williams, &c., who all extol the vegetarian diet ? Have I not said sufficient to show that vegetarianism is not the puerile and foolish doctrine generally supposed ? And may it not also be affirmed that it merits serious consideration ?

III

Flesh-eating and the Anti-flesh-eating Reaction in the Nineteenth Century.

From the preceding remarks, it may readily be concluded that present-day vegetarians are not innovators. They only, as has been well said, "restore to honour an age-long rule of life."

All the same, it may be remarked that, in our modern European society, vegetarianism as a practice up to the middle of the nineteenth century had but few followers, and these were isolated and unknown to one another. "To our generation," said Dr. Bonnejoy twenty-four years ago, "vegetarianism is a sort of novelty."

After being so long and so universally in favour, how did it come to be momentarily eclipsed, only to continue subsequently its forward march?

Flesh-eating received official scientific sanction about the middle of the nineteenth century. Medicine, ever on the look-out for new remedies and modes of healing, advocated excitants. It was not sufficient to recommend the generous wines of France and Spain. Blood-streaming flesh, either raw or roasted, was prescribed for any child who was weak or anæmic owing to a too rapid growth. The English roast-beef and beef-steak became types of a strengthening diet, replacing by the doctor's orders the traditional vegetable stew. To inaugurate the process of weaning, babies were given roast meat juice, and, in serious cases of rickets and scrofula, they were handed, instead of cake, a piece of raw bleeding flesh. These false stimulants were accompanied by a whole series of excitants. Coffee, tea, champagne, brandy and various liqueurs, always by the doctor's orders, were to be found on

every table where an endeavour was made, often at the cost of considerable sacrifice, to eat hygienically. All expected to find in such a diet not only health but strength to cope with the requirements of a period of intense activity.

It is well known what happened. After half a century's disillusions and disappointments, the system of administering excitants was condemned, at all events by intelligent people and by doctors whose desire it was to keep abreast of scientific attainment. It is scarcely necessary here to state that there was an enormous increase of nervous disorders, of arthritism in its endless varieties, of dangerous gastric and intestinal troubles the very existence of which was scarcely suspected a century ago. Treatment by stimulants and animal flesh was shown to be a failure; a change had to be made.

Alcohol was the first to pay its tribute to the public prosecutor. That is not sufficient, however; the war upon alcohol is now beginning to be extended to flesh-eating.

For some years past, the evil effects of a meat diet have been dilated upon by all who are interested in the public health. Doctors have begun to acknowledge their mistake. Along with such eminent pathologists as Bouchard and Lucas-Championnière, they acknowledge that the use of meat is a permanent cause of digestive inflammation and slow intoxication of the organism. Such famous clinicians as Dujardin-Beaumetz confess that, for most diseases, there is no efficacious treatment apart from a milk-vegetable diet. Finally, such physicians as Gilbert and Dominici tell of the immense quantities of pathogenic bacteria that swarm in the digestive canal as one result of a flesh diet.

Specialists also, without abandoning either pharmaceutical formulæ or the system of hot or cold

water treatment, insisted on by the patient himself, now go so far as to forbid their patients to drink coffee and alcohol or to partake of shell and other fish, of game and butchers' meat. To those who object, they still allow a little white chicken, though they mainly prescribe dairy-food and vegetables.

Tuberculosis is almost the only disease for which doctors continue to prescribe a large amount of flesh meat. The tendency is now to advocate a continuous air treatment. The meat treatment seems as though it cannot even yet be discontinued, for it is administered in the form of that filthy product of fatty degeneration, the cod-liver oil still given to children.

True, carnivorous habits have not yet been abolished in those classes of society which regard it as a duty to follow out literally the rules imposed by a tyrannous luxury. In high society, we cannot conceive of a ceremonial dinner or banquet apart from a dozen dishes of fish, meat or game. Again, such customs tend to be imitated by country people who nowadays seem ashamed of their frugal and simple food, and whose sole ambition is to attain to the comfort and well-being (?) of the town-dweller.

Thus we see that the flesh-eating tendency is by no means on the point of dying out. Still, the tendency towards a vegetarian renaissance, born of the excesses of the other, is beginning to spread, and nothing seems likely to impede the ever onward and acclerating progress of so welcome a reaction.

This extraordinary tendency we will now prove by giving a rapid sketch of vegetarianism in Great Britain, Germany, America, Switzerland, &c., showing approximately the status of the vegetarian bodies in these countries.

IV.

Gleizès and the Vegetarian Renaissance in England.

Gleizès, a Frenchman, was the great vegetarian apostle of the nineteenth century. He was born on December 26, 1773. His first important work, *Thalysie, or the New Mode of Living*, appeared only in 1840, when Gleizès was 67 years of age.

This work, which has deservedly been called the Bible of modern vegetarianism,[1] is not a scientific work, but rather a philosophic study, though its philosophy is far too nebulous and sentimental for the French mind. The result was that the prejudices which Gleizès attacked were not even shaken. "*Thalysie*," said Bonnejoy, "was but a flash in the dark, afterwards the night was blacker than ever."

Nevertheless, the seed was broadcast. Gleizès' theories, unappreciated in France, were warmly received in England, which became, if not the cradle, at all events the home of modern vegetarianism.

Speaking of the English, Gleizès said in 1842 :—

"Unhappy creatures, the use of flesh meat is destroying them. Look at them, like frozen serpents, seeking the sun everywhere outside their own island ! . . . But it is all to no purpose ; the poison has entered their very being. It is another warmth, another light that they need. . . ."

This light, which the French philosopher offered them, the English welcomed. Five years after this vehement objurgation, a Vegetarian Society was founded in Manchester, thus consecrating the

[1] It is not necessary to attempt an analysis of this enormous work of 1,300 pages in three volumes. Many of the thoughts it contains seem strange to modern minds, such as : the use of flesh is the direct cause of ugliness ; a diet of herbs develops beauty.

advance movement inspired by Gleizès. Similar societies quickly spread throughout the United Kingdom. In 1917, the oldest of them all celebrated its seventieth anniversary. Its organ is the *Vegetarian Messenger and Health Review*. In 1916 the subscriptions and donations amounted to £2,000, a sum which was spent on conferences, cookery demonstrations, &c.

The recent war, far from checking the efforts of this society, by reason of the cost of living and the difficulty of procuring food, aroused great interest and induced many to try the new regime, thus increasing the amount of business done by the various food reform stores.

In order to induce the people to adopt a less costly diet, the British Government published a cookery book, the majority of the recipes being vegetarian. Meatless cookery classes were held in Manchester and York, and many educational societies introduced food reform cookery in their domestic economy classes.

The proprietors of certain important journals organized competitions of meatless meals, followed by an exhibition of the dishes thus prepared. Innumerable articles on the subject appeared in all sorts of periodicals and reviews.

The war indeed compelled the Vegetarian Society to reduce the number of pages in its monthly periodical, though it did not bring about its complete suspension. Even the Vegetarian Summer School movement which began twenty-four years ago, was revived in 1916 with a larger proportion than usual of elderly people, the war having made a great call upon the young men. No Summer School was held the following year, owing to the critical stage of the war.

A far younger though no less important society

is the London Vegetarian Association. The President was Mr. Arnold F. Hills, the director of large ship-building works at Blackwall. Many of the workmen follow the vegetarian mode of living and also abstain from alcohol. They are at least as healthy as the others and as their diet is 50 per cent. cheaper than a meat diet, they are more prosperous.

At Wickford, Essex, twenty-nine miles from London, Mr. Hills set up a farm to give work to the unemployed. The Secretary of the Society summed up the situation as follows at the Vegetarian Congress of 1900: "We have in our ranks men who do the roughest manual and the most intense intellectual work, old men and people who have known want and destitution for years; and yet, owing to our mode of life, they have regained their activity and easily earn their livelihood by working on the land."

The London Vegetarian Association forms a large and prosperous group which organizes conferences, soirées, cookery demonstrations, &c. There are also several other societies which cannot all be mentioned, e.g., the Devon Vegetarian Society, an association divided into six branches, the Irish Vegetarian Union, and the West Ham Vegetarian Society. All the large towns, such as Birmingham, Cambridge, Folkestone, Newcastle, Coventry, Leicester, Brighton, Edinburgh, have their own vegetarian society. Each of these is the centre of a stream of propaganda by speech and pen.

Then there is the Vegetarian Cycling Club which proves to demonstration by means of extraordinary records the great superiority of a vegetarian diet in supplying energy from the point of view of sport. The deeds of prowess performed by George Olley, Parker Walker, Eric Newman, &c., have been

emphasized in a very interesting work by Mr. H. Light on the subject of vegetarian athletics.

Most of the large towns in the United Kingdom possess vegetarian restaurants. One of the best is the Food Reform Restaurant, in Furnival Street, London; another is the Eustace Miles Restaurant, in Chandos Street, close to Charing Cross. The principal vegetarian hotel is Hygeia House, 39, Warrington Crescent, London.

Throughout England there are various vegetarian restaurants, pensions and hotels, without mentioning four vegetarian sanatoria.

V.

Vegetarianism in Germany and America.

Germany entered into the vegetarian movement two years after England. There are two main societies which extend their influence over German-speaking countries.

The Leipzig Society dates from 1875. All its members also belong to the *Deutscher Vegetarier Bund* (the German Vegetarian Union), itself the result of the fusion of two former societies. Its influence is great; from being local, it has become national and even pan-Germanic. It has a monthly periodical, the *Vegetarische Warte*, though other periodicals, such as the *Vegetarischer Vorwärts*, a weekly paper, also uphold the cause. There are very active local societies in Vienna, Budapest, &c., and numerous restaurants. In 1914, the *Vegetarische Warte* gave a partial list of 146 establishments, including fifteen restaurants in Berlin and eighty-two throughout the rest of Germany, eight hotels, thirty-three pensions, and eight sanatoria.

Of course we know little of the movement in Germany since the end of the war.

Austria possesses only six vegetarian restaurants.

In Denmark, under the influence of the Danish Vegetarian Society and the Scandinavian Philanthropic Society, there have been established two vegetarian sanatoria, one in Gutland, the other near Copenhagen. Along the lines advocated by Dr. Slinhede, the Danish Government enabled this society to set up an institute for the purpose of investigating economic diet.

The Swedish Society includes over 1,000 members.

In the Netherlands, too, the movement is worthy of attention. When the first edition of this work appeared, there were 600 members, twelve restaurants or hotels at The Hague, Utrecht, Amsterdam, Rotterdam, Delft, Arnhem, Haarlem, and several sanatoria.

In Switzerland, where Hahn and Dock inaugurated the movement, there are six restaurants, one hotel, fifteen pensions and six sanatoria.

Italy and Portugal each has its own vegetarian society.

In Belgium a vegetarian society was founded by Dr. Nyssens. One of the best restaurants provides vegetarian dishes. Dr. Nyssens has also established an excellent sanatorium at Overyssche.

In Russia, vegetarian propaganda has been active of recent years, numerous restaurants have been opened in Moscow, including three by the Vegetarian Society.

But it is mainly in America that the movement assumed considerable importance over twenty years ago. In 1899 restaurants were opened in Chicago, San Francisco, Portland, Oregon, Topeka, &c. A college in which vegetarian principles were strictly

applied existed at that time in Washington. The students could live comfortably at an average cost of one shilling per day.

The emigration of the Russian Dukhobors increased by seven thousand the vegetarian population of the New World. The vigour and good health of these workers, who live exclusively on bread, fruit and vegetables, are much admired.

In the United States there are also many vegetarian hospitals and sanatoria, such as Dr. Reinold's Institute in New York and Dr. Anderson's in Chicago. At the Battle Creek sanatorium, patients and staff, including several hundreds, are all vegetarians. This sanatorium is directed and controlled by Dr. Kellogg.

In the Kellogg restaurants, &c., various alimentary products, nut and oil-seed extracts, all extremely nourishing, come first in importance. In Battle Creek alone there are more than twenty works continually supplying both the Old and New World with Kellogg products.

In New York there are eight vegetarian restaurants, almost all of which opened in 1902. Special mention should be made of MacFadden's restaurant, which is called the Physical Culture Strength Food Restaurant. At noon, the luncheon hour, every one of its 200 seats is occupied.

The diet, simple, varied and plentiful, includes soups made of peas and beans, barley flour, tomato, whole wheat, rice, Indian corn, and strength food, a special preparation consisting of nuts, oats and wheat. There is a great variety of *entrées*, while the drinks include milk, cereal coffee and unfermented wine.

MacFadden is also editor of two periodicals, the 375,000 copies of which, distributed weekly throughout America and Great Britain, are very popular.

Other important American periodicals are the *Vegetarian Magazine, Good Health, Naturopath* and the *Hygienic Review.*

Australia also is the seat of important vegetarian activities, carried on by the Vegetarian Society of Victoria and the South Australian Vegetarian Society.

VI.

French Vegetarianism—its Rapid Development.

As above stated, it was the Frenchman Gleizès who revived vegetarianism in 1840; but, as so frequently happens, he had no following in France until other countries had pointed out the way to put the diet into practice.

At the World's Exhibition of 1878, Dr. Dock, head of the Swiss Vegetarian School, spoke as follows at the Trocadéro: "The regime we follow ourselves and prescribe to our patients, even to those suffering from anæmia, is very simple: it consists of dairy produce, vegetables, farinaceous food, fruit, brown bread, no meat, no alcohol." He concluded his speech with the words: "The more simply we live, the more effectively do we resist morbid influences and disease generally, and the better does the whole organism function; the intemperate, however, labour unceasingly at their own destruction; of them it may truly be said: Man does not die, he kills himself! . . ."

Two years afterwards, in 1880, the Vegetarian Society of Paris was founded and the first number of the *Réforme alimentaire* published. This was the first and only number. The *Société de Paris* gave way to the *Société végétarienne de France* under the management of G. Goyart. At the same time the

Réforme alimentaire reappeared in a new cover. After an existence of only two years, both society and periodical came to an end. All the same, French vegetarianism was not dead; its revival soon came about.

In 1884 Dr. Bonnejoy published a book dealing with the principles of rational diet. This was a sort of preparation for the great work he brought out in 1891 under the title: *Le Végétarisme et le régime végétarien rationnel.* Dujardin-Beaumetz presented it to the scientific world in a very interesting introduction, concluding as follows:—

"For myself I have found my own cure in a vegetarian regime—a circumstance which fortunately enables me to repay a debt of gratitude by calling the attention of the medical public to a regime which is one of the most essential bases of that therapeutic hygiene which I have undertaken to defend."

These words of an acknowledged master bore fruit. Dr. Bonnejoy's book soon made its appearance. He was one of the most ardent champions of scientific vegetarianism. To him is largely due that vegetarian renaissance in France which is founded not on sentiment but on scientific truth. Bonnejoy, therefore, is rather a scientist than a philosopher in the strict sense of the word.

It was a time of discouragement. People were losing confidence in the virtue of drugs and meat and so-called restoratives containing alkaloids or alcohol. Many sick people were looking for salvation along other lines. On the one hand, the growth of the vegetarian movement in England and Germany; on the other hand, the famous cures of Kneipp and the efforts of Kühne, Rickli, &c., gradually paved the way for natural methods. Many families, without following a strictly vege-

tarian regime, began to diminish the quantity of meat they consumed and to practise a less exciting diet.

In 1898 the number of French vegetarians became sufficiently important for them to see the necessity of grouping together all their scattered and disunited forces; consequently, on January 23, 1899, on the initiative of a group of Paris vegetarians, and owing to the zeal of Dr. Nyssens and his young wife, the Vegetarian Society of France was reconstructed on a solid basis.

Dr. Jules Grand, director of the bureau, at once issued the following appeal :—

"In France there are far more vegetarians than any one imagines; their isolation, however, exposes them to various difficulties The prevalent prejudices and inveterate habits in matters of diet create in their environment a gentle, but more frequently, a bitter opposition. Those who, from personal observation or inquiry, determine to try the change, not knowing whom to ask for advice and enlightenment, meet with failure which is subsequently erroneously imputed to vegetarianism . . . In order to give moral support to both and the material facilities they lack, we need only put an end to this disastrous isolation.

"The importance of the object of the Vegetarian Society of France is greater than at first appears. Our race, exhausted by the continued use of exciting foods and drinks, will be freed by vegetarianism from a state of degeneracy and nervous disorder which, by depriving the will of all power of resistance, risks imperilling the future of the race as well as public and private morality.

"The tenacity of the errors to be destroyed requires great prudence. Avoiding any rigorous attitude, the society admits not only active members who

practise vegetarianism, but also associates interested in its propagation, although conditions of living prevent them from personally conforming to its rules."

The appeal was heard. At the first meeting thirty members joined. A year afterwards the society felt itself sufficiently strong to summon to the Paris Exhibition a great International Vegetarian Congress from June 21 to 23, 1900.

The meeting together of members from all countries gave considerable impetus to the French vegetarian movement, and ever since the society has continued to develop. Every winter it gave a series of seven or eight conferences, addressed mainly by doctors and professors of the *École de Médecine* of Paris. It is the principal merit of the society that, always proceeding along the line of science, it has brought the scientific and the university world round to ideas more in conformity with its own.

Before the war, the number of members had risen to 817, and the monthly periodical, published in common with the Vegetarian Society of Belgium, and entitled the *Réforme alimentaire*, gained increasingly in authority. Finally on April 12, 1908, there was opened in Paris, in the rue Notre-Dame-des-Champs, the vegetarian restaurant, Natura Vigor.

Inevitably, recent events reduced the effective power of the society, but food difficulties opened up the pages of such important dailies as the *Éclair* and the *Intransigeant*, which were glad to supply their readers with information and menus for meatless days.

One important fact may be mentioned. In Paris itself, M. Dalemont, manager of the great magneto works of the famous Nilmelior Company, has succeeded in establishing, within the works themselves, a vegetarian restaurant, where most of the staff

enjoy the best of food under particularly advantageous conditions.

Now a few words on international organizations. The *Deutscher vegetarier Bund* unites all German-speaking countries. Madame Veigelé, a French woman living in London, established a Women's Vegetarian Union. The Vegetarian Society of Manchester also had a certain international character.

It was replaced in this particular by the International Vegetarian Union, founded in 1908 at the Congress of Dresden. Since that year this Union has held other congresses : in 1909 at Manchester and in 1910 at Brussels during the Exhibition. A banquet contributed to the success of the congress. The result was that another congress was decided upon to take place at The Hague in 1913. This too was a great success and was to have been followed by one in Paris in 1916. It was the war that prevented this from taking place.

CHAPTER II.

THE PHYSIOLOGY OF DIET AND VEGETARIAN DOCTRINES.

A DISCUSSION had just come to an end on the subject of food regimes and vegetarianism. I had called on a friend and the discussion took place in the interval between the playing of a trio of Beethoven and one of Schumann. Though courteous, it had been rather a heated affair. I had successively refuted all the objections that had been raised, and silence had followed. Unable to bring forward further arguments and on the point of giving in, my friend, somewhat ironically and with a shrug of the shoulders suddenly remarked: "So you would do away with the roast, would you? I tell you, it's perfectly absurd! My cook would not remain another day if you were to deprive her of her roast!"

Must I confess that I almost expected such a protest; the tyrannies of fashion are so well known! . . . I am aware that many people look upon the question of the roast as one of the most important in life. But, after all, are you masters in your own homes? Given the choice between exact scientific teaching and kitchen prejudices, will you abandon the narrow path of truth and the important interests of health, because you are afraid of being ridiculed by your friends or wish to avoid giving offence to the servants?

Why pay attention to snobs systematically enslaved to certain conventional ideas? And why trouble about those timid and indecisive people who confess that a reform is right in principle but object to carrying it out in practice.

It is our duty to believe firmly in demonstrated truth. Rising above all paltry and mean prejudice, we may appeal to physiological experiment and a well-conducted physico-chemical analysis to solve the important and difficult question of diet. While thus finding out the origin, nature and exact rôle of the various foods, we shall discover that the vegetarian regime is really sufficient for the needs of the organism, for the perfect and harmonious unfolding of strength and health.

II.

Complete Foods.

If questioned on the problem of diet, most people are reduced to the statement that what they mean by food is: everything that is eaten. A complete list of foods, you will be told, is to be found in cookery books; to become acquainted with them, one need only make a tour of the market place or inspect the shops of the main provision dealers. To conclude the explanation, we are informed that food serves to keep us alive and that its rôle in the body may be compared with that of coal which maintains heat in a *calorifère*.

Reduced to this simplified expression, the idea we form of food is confused and erroneous; in any case, it does not enable us to form any opinion whatsoever on questions of diet.

To be more precise, everyone knows that the vital process is evidenced by the loss of matter and the

expenditure of energy. Matter is rejected along the usual channels of elimination (the products of respiration, perspiration, excretion, &c.). Energy is employed in the production of heat enabling us to resist cold, and in the development of the strength necessary for our activity. In the adult man, perfectly balanced as regards nutrition and health, the true equilibrium between receipts and expenditure is effected by the daily consumption of food. We may therefore admit that: Food is that which, when absorbed by the organism, serves to repair the losses of the body and to maintain the play of its strength and activity.

Basing his conclusions on this definition, Liebig, the famous German chemist, long ago classified food in two categories. The ones repairing the material losses of the organism become incorporated with its fibres and elements and identified with it; these are the plastic foods. The others, combining with the oxygen breathed in, and, as it were, burning within the body, produce heat and release the forces of life; these are called combustible or respiratory foods.

The impossibility of distinguishing clearly between these two kinds of food has led to the adoption of a chemical classification. The biological chemist sees and distinguishes very simple alimentary chemical species to which the recipes of the most sumptuous menus may always be reduced. Whatever high-sounding names you give to the wonders of the culinary art, you will find nothing in them that cannot be reduced to the following fundamental species—albuminoids, fats, hydrates of carbon and minerals.

We will give a few instances of each.

The albuminoids, still called proteids or nitrogenous substances because they are rich in nitrogen,

have for their type the albumen of white of egg and the casein of clotted milk. They are largely to be found in the living matter of vegetables and animals.

Hydrates of carbon and fats contain only three elements: carbon, hydrogen and oxygen. Fats are represented by butters, oils, &c. Hydrates of carbon include sugar along with its many varieties, starches, dextrins, gums and mucilages.[1]

Lastly, minerals are the different salts—chlorides, carbonates, phosphates and ferruginous substances—which impregnate every natural food. Their presence is everywhere necessary in the living organism, and some, such as salts of iron and phosphates, are so essential in processes of nutrition and growth that they form one of the fundamental bases of diet.

It has been proved that each of the preceding substances is indispensable to life.

Pettenkofer, Voit, and Boussingault have proved that the animal, if deprived of proteids and nourished solely on starches and fats, rapidly deteriorates. On the other hand, by feeding dogs on large quantities of lean meat Tiedmann and Gmelin noticed that they become feebler and that fat or starch must be added to their diet.

The necessity of water is indisputable. A simple daily ration of water aids a prolonged fast, whereas the most nourishing diet, deprived of water, leads to death. Compare the well-known fasts of Tanner, Cetti, Succi, &c., undertaken for scientific purposes.

Finally, the experiments of Chossat on bone-

[1] According to Liebig's classification, water, albuminoids and mineral salts are plastic; fats and hydrates of carbon are combustible.

formation, of Boussingault on the growth of swine and of Forster on the decline of animals deprived of mineral salts, prove the nutritive importance of these salts.

These results, moreover might have been foreseen. Analysis proves that water forms nearly 80 per cent. of the entire weight of the human body; albuminoids, minerals, fats and hydrates of carbon form the rest. Now, the essential characteristic of life is the perpetual renewing of all constituents of the body. Slowly but regularly the albuminoids are destroyed, the respiratory matter is consumed, and the water which dissolves the products of this destruction carries them away along with the mineral substances to the eliminatory passages which expel them from the organism. It is these losses which the receipts must balance, and since expenditure includes both water, proteids, combustible matter and mineral salts, all these equally indispensable substances should be found in the diet.

What we mean precisely by a complete food is any natural food which, containing the whole of the above defined chemical substances, is of itself alone capable of maintaining life.

The type of a complete food is milk on which the young mammifer feeds exclusively. It may also be admitted, with certain reservations, that the egg, which suffices for the development of the young bird, is a complete food.

Dealing with the composition of milk, regarded as the most perfect complete food—a somewhat arbitrary supposition — Liebig concluded that a complete dietary ought to supply 25 per cent. of nitrogen and 75 per cent. of other matter. We shall presently see that this proportion of nitrogen is certainly exaggerated.

III.

Chemical Analysis of the Principal Foods.

Of the foods usually consumed, some are rich and others poor in nitrogen. Certain are to be recommended for their abundance of respiratory matter, whilst others are chiefly of mineral constitution.

It is exceptional for the same aliment to contain everything indispensable to life in the right proportions. Indeed, complete foods are rare. Consequently we are wont to combine various sorts of the usual foods so as to obtain a complete dietary. To do this, we must know the nutritive value of each article of food.

Names of foods	Water	Dry proteids	Fats	Hydrates of carbon	Mineral salts
Flesh of Mammifer...	780	170	50	4 to 5	9 to 15
Roast beef	699	229	51·9	—	10·5
Chicken	780	200	—	—	11
Egg	756	122	107	5	10
Liver	720	130	35	18	14
Cow's milk	865	36	40	55	4
Fish	740	135	45	—	15
Wheat	140	146	12	679	16
Barley	130	134	28	636	45
Oats	140	119	55	615	30
Indian corn... ...	177	128	70	599	11
Rice	144	64	4	781	6·8
Lentils	115	265	25	580	16
Potatoes	760	15	2	200	10
Grapes	810	7	—	150	5
Dry figs	290	40	13	634	27
Almonds	54	242	537	72	29
Broth	985	6	—	—	3
Bread	330	88	10	550	17
Vermicelli	131	90	3	768	8
Cheese (Gruyère) ...	346	335	250	—	33·5

The above table, which contains a few of the most interesting examples, gives in grammes the

weight of each food per kilogramme of substance analysed.[1]

As might have been expected, milk and eggs are found among the complete foods.[1]

It may be remarked that meats rich in nitrogen, though poor in respiratory matter, are not complete foods.

On the other hand, one is struck by the nutritive value of cereals (wheat, barley, oats . . .) and especially of legumes (lentils, peas, haricots). These foods, while being as rich in nitrogen as animal flesh, contain a considerable quantity of starch, and a great deal of mineral matter. Thus they are complete foods.

True, the cereals contain only 20 per cent. of proteid, whereas the others have 25 per cent. In rice the proportion of proteid falls even below 10 per cent. Still, what difference does this make? Do not whole nations feed almost exclusively on cereals? And are the Chinese and Japanese less robust because of the rice which supplies them with so little nitrogen? All the same, it is important to note that bolting deprives cereals of the virtue of being complete foods. Magendie kept dogs alive by feeding them solely on black bread. On the substitution of white bread they began to decline. This important question will be referred to more fully in the following chapter.

In the same analytical table the reader will note

[1] The reader who would like to have more detailed information on this subject may refer to the analyses of Wurtz, Payen, Boussingault, &c. He will find nothing more complete than the important German work by König (*Chimie der menschlichen Nahrungsmittel*, von Dr. J. König, Julius Springer, Berlin.) See also the excellent tables of J. Alquier (*Les Aliments de l'Homme*). Paris, Masson, 1906.

[2] In this table the complete foods are given in italics.

the incomparable nutritive value of almonds and oleaginous fruit. Cheese also largely contributes to the nitrogen ration in our menus, whereas meat broth (a pound of meat to a quart of water) possesses scarcely greater nutritive value than does water. On this matter see the next chapter.

The richness in minerals possessed by certain foods, such as cereals and legumes, should be noted in passing. The following table of mineral analysis gives in grammes the weight of each salt per kilogramme of food.

Articles of food	Potash	Soda	Lime	Iron oxide	Phosphoric acid
Meat	3·7	1·0	0·24	0·04	4·1
Egg	1·7	2·2	1·0	0·04	3·7
Milk	1.0	0·32	0·9	0·01	1·2
Wheat	4·8	0·49	0·5	0·21	8·0
White bread	—	—	—	—	1·5
Black bread	—	—	—	—	6·6
Barley	9·45	1·08	1·1	0·53	15·0
Oats	5·4	0·48	1·08	0·35	7·5
Lentils	5·5	2·16	1·0	0·32	5·8
Peas	9·8	0·23	1·19	0·2	8·7
Potatoes	6·6	0·29	0·26	0·03	1·7
Nuts	—	—	—	—	8·7
Spinach[1]	2·3	6·96	2·28	0·6	1·2
Lettuce	3·7	0·81	0·48	0·54	0·96
Cabbage	3·38	1·82	1·95	0·208	1·69
Onions	1·75	0·224	1·54	0·308	1·05
Carrots	2·86	1·63	0·85	0·07	0·93
Mushrooms	—	—	—	—	10·0

[1] With reference to these fresh vegetables, the figures relate to 1,000 grammes of fresh substance.

Cereals, legumes, oleaginous fruits, mushrooms, certain fresh vegetables, are twice as rich in phosphoric acid, and ten times as rich in iron as is flesh meat. Now, the use of phosphoretted foods is of capital importance. Phosphorus is useful in building up the cellular nuclei, i.e., in the regeneration of living matter itself, and the physiologist rightly regards it as the most precious of the chemical

elements required for a rational dietary. And is not iron the one essential element in the regeneration of the blood? To these lists there might also conveniently be added the analysis of various other foods. Some of them, such as asparagus, watercress, cabbage, are remarkable for their richness in nitrogen. The lettuce has the composition of milk, blended with two or three times the amount of water. In short, as we have just seen, most green vegetables, salads and roots, are distinguished for their extraordinary mineral properties.

IV.

Remarks on the Choice of Albumens, and on the Fundamental Rôle of Salts and Vitamines.

At this point stress may be laid on the rôle of certain substances, the absence of which in rations that are richest in energy brings about a rapid decline and frequently death. The well-known beri-beri of oriental populations inadequately nourished on rice, and the scurvy prevalent in eaters of tinned foods, are prototypes of those formidable diseased conditions rightly called *maladies par carence*—from the Latin words *carentia*, a lack, or *carere*, to be without—seeing that they are caused by the absence of food material indispensable to life.

Our attention must be directed to three things: (1) the choice of albumen, (2) the rôle of salts, and (3) the supreme importance of vitamines.

(1) *The Choice of Albumen.*—None but those substances containing albumen have the power to repair our protoplasm—the living matter of the body—in proportion as it is used up in vital combustion. As this wearing-away process is scarcely perceptible, the albumen ration should be very small; still, if it

is to be of a renovating nature, this small ration of nitrogen should be chosen from the true albuminoids, the molecule of which contains all the chemical elements essential for building up our living matter, and particularly tyrosin and tryptophan, the essential chemical nuclei of protoplasm. Now, collagenous substances—gelatine, the chondrin of cartilages, the ossein of bones, and, more serious still, zein, the albuminous matter obtained from Indian corn, do not contain these essential chemical nuclei. Consequently they cannot take the place of true albumens, and the man who relied on them for his ration of nitrogen would speedily fall, by *carence* or deprivation, into a most serious physical decline.

Clearly these substances contain nothing harmful in themselves; they become so only if we give them in our dietary the place due to the true albumens, the renovating rôle of which they are unable to perform.

These facts have been brought as a decisive argument against vegetarianism. "Meat," it is alleged, "the albumen of which is so rich in tyrosin and tryptophan; meat, so similar to our own flesh; meat, endowed with incomparable renovating properties, is therefore necessary, in small quantities, at all events." What an argument! Do not the horse, the ox, the sheep and the multitude of herbivorous and frugivorous animals build up and renew their flesh on vegetable albumen alone? As a matter of fact, the use of vegetables, grains and fruits exposes vegetarians far less than flesh-eaters to the consumption of false albumens.

(2) *The Biochemical Signification of Salts.*—Mineral salts keep the saltness of the blood in the right proportion, seeing that our cells and tissues are intended to live, not in a demineralized environ-

ment, but in a sort of brine salted to the extent of 0·8 per cent. or 1 per cent. The various salts also, chlorides, phosphates, carbonates . . . of potash, soda, lime, iron, manganese, enter into the constitution of the tissues themselves. More than this, they supply the living cell with the mineral material with which it makes the numerous diastases—the biocatalysers—which are the indispensable tools of its activity. Deprived of salts, the most active organism becomes inert and powerless. It is no more than a clever workman without his tools, a brilliant virtuoso trying to play his violin without a bow. Above all, do not forget that these precious salts abound in the husks and chaff of grains and cereals, and draw from these facts the practical conclusions they carry with them.

(3) *The Importance of Vitamines.*—Thus a nitrogenous ration of collagens (gelatine, cartilage), accompanied with demineralized food (excessively white bread, decorticated grains, vegetables deprived of their salts by prolonged cooking—unless the water in which they are boiled is utilized), must inevitably lead to a state of degeneracy in two ways, from *carence* of true albuminoids and *carence* of mineral salts. There is also a third form of *carence* —perhaps even more dangerous—*carence* owing to lack of vitamines, or, as Funk calls it, *avitaminase.*

The classic instance of this is supplied by beriberi, that dreaded and usually fatal degenerescent condition which mainly affects the nations that feed on rice (Brazil, Africa, India, China and Japan). And yet it is not rice that is really to be blamed. Eijkmann first and afterwards Funk have proved that beriberi attacks only those who feed on very white rice that has been deprived of its outer silvery pellicle—*paddi*—by a process of polishing, the disastrous refinement of the grinding process! The

same thing happens in the case of pigeons fed on polished rice. On the other hand, those people or animals that feed on unpolished rice escape beriberi and develop admirably. A thing still more remarkable is that if anyone suffering from beriberi partakes of even the smallest amount of the residue from the polishing of the rice, he is rapidly, almost miraculously, cured of this terrible disease.

Then what is the substance which produces this wonderful effect on life? It is neither an albuminoid nor a mineral salt. Funk, who isolated it from paddi, proved that it is a special crystallizable nitrogenous substance, the formula of which is $C_{17}H_{20}A_2ZO_7$, to which he gave the name of vitamine, seeing that it is indispensable to life.

It is also to a loss of particular vitamines—owing to tinned or preserved food being kept too long—that scurvy must be attributed. Sterilized milk, excessively white flour, on which infants are so often fed, being deprived of vitamines, are also responsible for such serious infantile disorders as tabes, athrepsia and rickets.[1]

It is consequently important to know what foods are rich in vitamines. These are mainly vegetable substances: undecorticated cereals and all fresh vegetables (cabbage, carrots, leeks, peas), chiefly the potato, if the water in which these have been cooked is utilized; then fresh fruits and their juice (currants, raspberries, especially oranges and lemons).

Boiling does not destroy these vegetable vitamines;

[1] All the same, from eight to ten months of this lacto-farinaceous regime, with its shortage of vitamines, elapse before serious trouble occurs; showing that the new-born babe brings with him a reserve of antiscorbutic vitamines which he slowly exhausts. Like disturbances may even take place in the breast-fed child if the mother's food is lacking in vitamines.

this would not appear to be the case with animal vitamines.

Milk remains suitably vitamined when fresh, or even when subjected to very rapid boiling up to the moment when it rises. Sterilization, on the other hand, a double boiling, and even prolonged heating at 100° F., deprive it of necessary ingredients.

The egg contains vitamines in the yolk only; boiled beef contains none at all, they have passed into the water. Moreover, there is reason to fear that prolonged cooking destroys the vitamines of meat.

The following, then, is a list of foods devoid of vitamines: milk, either sterilized or boiled more than once, white of egg, boiled or preserved meats, decorticated cereals, pastry made of white flour, polished rice, too white bread, preserved vegetables, dried fruit.

In short, brown bread, potatoes, fresh fruit and vegetables are needed to supplement the large nitrogenous and combustible rations of albumen, fats and hydrocarbons, so rich in energy.

This instruction, both theoretical and practical, is of the utmost importance; the reader will do well to remember it. Let him also guard against a dangerous statement nowadays very much in vogue amongst certain vegetarians and naturists. They think that recent information relating to the part played by salts and vitamines and to the mechanism of *maladies par carence* has definitely killed the theory of calories in problems of diet! This is absurd; indeed, the question of calories in diet is no theory, it is a primordial fact of brute reality. When an organism expends 2,500 calories per day, it must find them in its daily ration of food, unless it burns itself up completely. That is one kind of *carence* which is anything but new; it has always been

known under the name of inanition! Do not let any preoccupation about salts and vitamines trouble you to the point of making you forget to give your motor the load of fuel it imperiously demands, i.e., the store of combustible energy needed for its functioning. But remember that this is not enough, and that the body must also have salts and vitamines to carry through the chemical operations necessary for its vital activity.

V.

The Diet Ration from the Dual Point of View of Matter and Energy. Critical Study of the Nitrogenous Ration.

The maintenance ration is the quantity of food needed to keep in perfect balance the health of an average adult who does not overwork himself either intellectually or physically.

It must not only repair losses of matter but retain the reserve of energy expended daily.

To determine the amount of this ration, A. Gautier measured the quantity of matter lost daily by the organism. He found that the normal maintenance ration ought to contain 120 grammes of albuminoids, 50 grammes of fat, and 400 grammes of carbohydrates.

There is another method, that of averages. Taking the municipal statistics of Paris and comparing the imported food products with the numbers of inhabitants, A. Gautier found that the Parisian's average ration was 115 grammes of albumen, 48 of fat and 333 of carbohydrates. Slightly less than the former, this average is also inferior to that which Moleschott calculated for Germany, viz., 120 of albumen, 84 of fat and 400 of

carbohydrates. According to L. Lapicque, the average adult Parisian needs 124 of albumen, 80 of fat and 494 of carbohydrates.

For a working population, Pettenkofer and Voit calculated 120, 74 and 400 respectively.

In combustion within the body, this matter releases from 2,600 to 3,000 calories.[1] These rations, however, are assuredly too high. Moreover, it is clear that they are determined on a false principle, for even though, with A. Gautier, we measure the ration according to the amount of expenditure, it must not be forgotten that this very expenditure depends on the amount of the receipts, i.e., on the dietetic habits of the subjects under observation. In both cases, then, we raise habits to the level of psychological needs : a serious error. As a matter of fact, there are numerous instances of people who live on a ration of less than 2,000 calories.

Besides this, how can we help doubting the amount of nitrogen proffered by physiologists ? As we have already remarked, Chinese and Arabs live well on an insignificant nitrogenous ration.

During the siege of Paris, soldiers engaged on hard work and subjected to intense cold received only 60 grammes of albuminoids, i.e., half the ration stated by Voit and Gautier: the total energy of their diet never went beyond 2,500 calories.

In this connection, certain experiments are eminently suggestive. Hischfeld, in an eight days' test upon himself, maintained his supply of nitrogen with a ration of 3,400 calories which contained only 42·05 grammes of albumen. This author weighed 73 kilogrammes. But Kumagawa, who weighed only 48 kilogrammes, daily absorbed 48 grammes of

[1] A calorie is a unit of heat, the amount of heat needed to raise a kilogramme of water one degree.

albumen, with a ration of 2,480 calories reduced to 38 grammes of nitrogen. Peschel, who weighed 77 kilogrammes, even kept up his supply of nitrogen with 32 grammes of albumen. And finally, Lapicque and Marette, in the case of a subject weighing 73 kilogrammes, maintained his supply by using a daily ration of 3,000 calories containing 57 grammes of albumen.

To these remarkable facts—though relating to experiments that lasted only a few days—it is well to add the interesting tests made by Lapicque on the food regime of Abyssinians and Malayans. The Abyssinians content themselves with the flour of a gramineal, the *durrha* (*Sorghum vulgare*), only a few sometimes adding a little dairy produce, legumes or meat. The Malayans add to their rice tiny quantities of fish or fowl. Weighing on an average 52 kilogrammes, they live on 2,000 calories and maintain their supply with a maximum of 50 grammes of albumen. It is unnecessary to draw up chemically a table of their diet to prove that this ration is sufficient for them: on such a regime these races have for centuries developed normally, working hard all the time. These facts of themselves answer every theoretical objection.

Taking the average of all these results, we find that a man weighing 60 kilogrammes can live and even work with a ration of from 2,000 to 3,000 calories, reduced to 45 grammes of albumen!

This is far different from the 120 grammes of albumen stated by the above-mentioned experimenters, in accordance with the diet excesses habitual in great European cities.

The reason I dwell upon this excessive quantity of nitrogen in one's diet is that the matter is serious. Complete combustion of nitrogen in the organism being exceedingly difficult, the man who absorbs it

in excess rapidly falls into one of those dietetic disorders which range from gout and slight arthritis to diseases of the intestine, the liver and the kidneys.

We reach, then, the following conclusions :—

(1) The average middle-class European absorbs a very large amount of nitrogen containing a minimum of one-third or a quarter proteid matter and releasing a total energy of 2,600 calories.

(2) Observation proves that, given the same conditions of climate and existence, it is possible to live on a ration of one-half less nitrogen and far less in bulk. Thus we may avoid those dangerous maladies which result from a diet too abundant and too rich in nitrogen.

When dealing with a man engaged in hard physical work, the former maintenance ration must be supplemented by another more in proportion to the intensity of the work. This is the working ration.

It has been calculated that a robust workman needs an extra diet energy of from 1,500 to 2,000 calories.

The learned works of Chauveau, however, have proved that the organism which works burns only glucose sugar and that this work is effected without any increased nitrogenous expenditure. Consequently, it is quite useless to introduce albuminoid matter into the work ration. Indeed, it is clear that, if the organism calls for glucose sugar when work is to be done, one cannot do better than supply it either with this very glucose or at least with the amount of carbon hydrate and fat which supplies 2,000 calories.

It may be noted that neither alcohol nor infusions of tea or coffee need enter into a diet ration. True, alcohol releases 7 calories when burning in our lamps; but in the human body, the apparent strength it causes is nothing more than a dangerous

surexcitation of the nervous system. The same may be said of coffee and tea which have no nutritive value whatsoever. These alleged dynamophores act only as excitants which compel the organism to supply energy which it does not possess or which it borrows from its reserve of vital irritability. Moreover they are of the same composition as certain urinary excreta and have not the faintest claims to be considered as foods.

Condiments of themselves contribute nothing to the nutritive ration. The only really useful one is table salt which is already present in most natural foods; it is used in too large quantities for the purpose of restoring to food the savour of which it has been deprived by careless cooking.[1]

Finally, the remarkable effect possessed by food essences on the mechanism of digestion is well known. These essences abound in many vegetables and ought to be retained in our food if we would ensure for it perfect digestibility.

VI.

Regimes of Diet. The Inadequacy, Danger and Illogicality of a Flesh-eating Regime.

The preceding part of this chapter was necessary to enable the reader to appreciate the various dietetic regimes offered to man.

The word "regime" (from the Latin regere, to govern), synonymous with the word "diet" (διαῖτα), indicates the reasoned and methodical usage of food, and of everything essential to life and the preservation of health.

[1] The mistake consists in throwing away the water in which vegetables have been cooked, i.e., in demineralizing them.

What then should man eat in order to be in good health? It is for a food regime to define this. Unfortunately, whereas the animal, guided by infallible instinct, has no difficulty about what to eat, man hesitates and makes mistakes.

We have already seen that a flesh-eating regime, the development of which invariably coincides with a recrudescence of passion, sensuality and luxury, has been combated in the name of wisdom, morality and health, by philosophers and leaders of scientific and religious thought who have constituted themselves the defenders of a vegetable regime.

At present it is taught that the regime should be a mixed one. Food is taken from both kingdoms, this being explained by the statement that man is omnivorous. The opinion is of no value; we have only two systems, only two doctrines to consider: more or less pronounced flesh-eating and anti-flesh-eating.

Speaking of the present vegetarian renaissance, I maintain that this movement, disburdened of its original sentimental form, has acquired the force of scientific truth. This affirmation will now be proved by making a critical investigation of the two opposing systems.

I now affirm and shall proceed to prove that the flesh-eating system is manifestly inadequate; that it is unhealthy and contrary to a wise observance of the harmony of nature.

If we consult the analytical table in the earlier part of this chapter, we find that a kilogramme of meat is only one-fifth nitrogen and that the other four-fifths is water. Animal flesh, with the fat removed, as is generally the case when it is eaten, contains none of the elements essential for heat and strength and affords but a slight mineral ration. If half a kilogramme were eaten daily, we should not

have even Voit's ration of nitrogen, and it would be necessary to find elsewhere the four-fifths of a kilogramme of respiratory matter necessary.

If you attained the impossible, and succeeded in absorbing the enormous proportion of 2 to 3 kilogrammes of lean meat, even then you would not have obtained your vital ration and would only have made yourself ill.

Not only is a flesh-eating regime inadequate to maintain life, it is also extremely unhealthy. Nothing could be more favourable to fermentation than a medium containing a large quantity of nitrogen. In the digestive tube, the work of fermentation will produce numerous toxins swarming with an endless number of bacteria; these toxins will supplement those already naturally contained in meat. Finally, within our tissues and organs these poisons will again blend with those arising from inadequate combustion of this excessive nitrogenous ration. The uric acid and the numerous purins (animal poisons) resulting from this defective diet will impair the blood, producing gout, rheumatism, endocarditis and organic diseases of the heart, inflammation of the arteries and arterio-sclerosis, chronic gastro-enteritis, appendicitis, peritonitis, nephritis and kidney disease, and lastly innumerable skin troubles which have their true origin in the ingestion of a nitrogenous ration.

To this criticism is also added another and a very serious one, of a decisive character for those who would respect the natural order of things.

Just consider the wonderful and perfectly adapted structure of the animal you eat. Everything in this organism functions for a definite purpose: the perfection of being. In the play of its ventricles, auricles and valvules, the heart performs a very definite work, intended to drive the blood regularly

through the blood-vessels for the distribution of the elements of life. The blood, contaminated by the nutritive process, finds in the lungs the conditions necessary for the renewing of its gases. It stores nutritive matter in the digestive apparatus whilst ridding itself of its impurities by traversing the kidneys and the liver, which are, so to speak, the body's great collecting sewers. Note that all this takes place in the most perfect fashion imaginable and in wonderful order; each organ comes into play at the right moment and ceases its activity as soon as its part is played. For the governing of all these parts, there is a co-ordinating force peculiar to the animal. With this fine delicate structure and the incomparable precision of its physiological processes, the nervous system is the highest expression of vital perfection. Is not the brain the marvellous instrument whereby the soul brings into harmonious collaboration the many organs, the varied anatomical elements whose concerted action produces the extraordinarily developed life of the animal?

It would also be impossible to admire too greatly the mysterious process of animal sensibility. There is eye, ear, nose—sense organs which collect influences from the outer world and bring them, along the track of the nerves, right to the brain, by means of which an immaterial being, a soul, sees and hears, suffers and enjoys, expresses its passions, its joy and anger, gratitude and hatred.

Lastly, you have admired the skill and strength of those thousands of living species on which Nature seems determined to lavish before our astonished eyes her infinite resources of grace and beauty, offspring of a creative intelligence. . . .

And yet it is these marvels of psychic, æsthetic and physiological perfection that are destined to be converted into sausage, beefsteak and black

pudding! People would have us believe that ruminants possess a stomach, not for purposes of digestion, but for supplying us with tripe, that the purpose of the kidneys is not the filtering of urine but the cooking of a stew . . . They would have us believe that Providence has been compelled to give to this graceful, supple and vigorous body, of the most exquisite sensibility, a soul endowed with marvellous instincts, all for the purpose of supplying us with hot-pot, leg of mutton and garlic, veal with vinegar sauce, and sheep's trotters with truffles!

What right have they to attribute such insane fatuity to the Creator? . . . Has it ever been maintained that wood must necessarily assume the form of a fine Stradivarius violin or of a Pleyel piano before it can be utilized in making a fire? Will it be alleged—a thing infinitely more insensate—that the logic and order of creation require our nourishment first to assume the wonderful form of the animal organism before earning the right to fall into our pans and stew-pots? . . . Finally, was it necessary that this flesh should carry on a desperate struggle for long hours against a savage pack of hounds and submit to an undeserved defeat only to appear, shapeless and bleeding, on our banqueting tables?

No, a thousand times no! The animal was not created to be eaten; such a claim is as intolerable to science as to common sense. In this connection I refrain from discussing the futile argument of your rights as a human being, and the lordly dominion given to you over Nature. Never, so far as I know, has the investiture of royalty been legitimately invoked by the head of a State as implying the right to massacre his subjects!

VII.

Physico-chemical Justification of Anti-flesh-eating Systems. Critical Investigation of Digestibility. Fruitarianism, Vegetalism, Vegetarianism.

The more illogical the flesh-eating system is, incapable, with its excess of nitrogen, of supplying a healthy and complete diet, the more lavish the vegetable kingdom shows itself to be, not only in its variety and abundance, but in food reserves best adapted to the effective working of the organism which consumes them.

If we consult once again our analytical table, we find that the cereals possess nitrogen, hydrates of carbon and mineral salts. Wheat, barley, oats, Indian corn are indeed complete foods, unless sifting and bolting are employed to separate the nutritive envelope from the grain.

Does not daily observation verify these theoretical inductions ? Wheat is bread, the dietetic principle of all human beings. Mixed with Indian corn, torrefied and finally ground, it is converted into a white powder which the inhabitants of the Canary Islands call *gofio*. They make a paste of it, unleavened and uncooked, and simply content themselves with giving it shape. Then they cut it into slices which they eat without preparation or mixture of any kind. On this alone lives that vigorous and fine race which recalls to mind the Gauls of Vercingetorix. Oatmeal, too, is the national food of the hardy Scot.

Rice is the essential diet of one half of mankind. The legumes—peas, beans and lentils—are even more nourishing; perhaps too nourishing! Containing more nitrogen even than does flesh-meat, abundantly provided with starch and mineral matter

in which iron and phosphoric acid predominate, these foods should be partaken of but moderately, otherwise the drawbacks of a ration containing too much nitrogen would become manifest.

Certain fruits, such as almonds and nuts of various kinds, are even superior in the extreme concentration of their nutritive constituents. Here, as it were, we see the triumph of Nature as regards concentration of diet. These grains contain but very little water; their nitrogen is twice as abundant as in meat. Not only is there a large amount of phosphoric acid and mineral matter along with a notable quantity of starch and sugar, but also an abundant reserve of fats, the output of which in calories and energy is double that of sugar and hydrates of carbon.

Special mention should be made of sweet fruits. Being very deficient in nitrogen they cannot be regarded as complete foods. What they do give us, however, is glucose itself, i.e., matter which the organism consumes direct and without the labour of transformation. While useful enough in the composition of a physiological maintenance ration, it is of undoubted value as an extra work ration.

The objection is at times made that a vegetable diet is but moderately digestible, and that this regime supplies too abundant an intestinal residue to be as healthy and nourishing as the animal regime.

Thus formulated, this affirmation is ambiguous and erroneous. It is well known that sugar leaves but an insignificant residue; the same may be said of rice and pastes. In a table of comparative digestibility we find the following values of the intestinal residue per 100 parts of dry substance:—

Rice	4·1
White bread	4·5
Meat	5·2
Egg	5·2
Milk	9·0
Potatoes	9·4
Peas	11·0
Black bread	15·0

This table clearly shows that animal substances are far from being first in the scale of digestibility. If we take as type the 9 per cent. digestibility of milk —which indeed would appear to be an alimentary prototype—it is clear that the average of the ordinary farinaceous foods (rice, legumes, potatoes) is nearer the ideal figure than meat and eggs.

Black bread and a few fresh vegetables alone, by reason of their cellulose, leave behind a higher residue. Instead of being sorry on this account, let us remember, as a fact of most elementary hygiene, that their proper use will cure constipation and bring about that gentle and regular intestinal action at which every healthy diet should aim, in maintaining the efficacy of the digestive apparatus.

Affirming that food should undergo no culinary preparation of any kind, that man is essentially frugivorous and not herbivorous, and that fruit alone is capable of being absorbed raw, certain opponents of flesh-eating are content to eat fruit alone. These go by the name of *fruitarians*.

Less strict in that they accept the principle of cooking food, though they consume only vegetable matter, the vegetalians refuse even milk and animal products. The doctrine they profess may be called *vegetalism*.

We now know that a properly balanced fruit regime ensures the healthiest and most complete

diet. Still, most of the opponents of flesh-eating have adoped a wider range of food ; to the whole of the vegetable kingdom, the vegetarians add eggs, which are very useful in the preparation of various dishes, and milk, with its products, cream, cheese and butter. These introduce a pleasing variety into our recipes and our menus.

We must make a distinction between vegetalism and vegetarianism. Vegetarianism does not mean a vegetable regime ; the word is derived from the Latin adjective *vegetus*, meaning vigorous and active. Thus the vegetarian regime is synonymous with one that gives strength and health.

It is to this diet of vegetables, eggs, and milk, that most robust and healthy populations have remained faithful.[1] The Russian peasants, the miners of Chili, Mexican, Brazilian and Chinese workmen, aborigines of the Canaries, Egyptian and Greek watermen, porters or carriers from Smyrna,[2] Turkish soldiers, farm labourers in Sweden, Italy, Switzerland, Bavaria, Turkey, &c., live solely on bread, fruit, vegetables and dairy produce. They all have remarkable muscular strength.

These facts should not be forgotten, seeing that they complete the physico-chemical doctrine just stated and supply striking justification of vegetarian theories.

This chemical point of view, however, is not the only one. We may consult the teaching of anatomy ;

[1] The food of the Greek athletes consisted solely of figs, nuts, cheese, bread and μαζα, a sort of unfermented cake. The black broth of the Spartans is legendary. It was not a meat diet that inspired in their compatriots the splendid and glorious defence of Thermopylæ.

[2] Fed exclusively on black bread and vegetables and fruit, these men can carry formidable loads weighing over 300 kilogrammes.

investigation in this direction will make things even more precise by affording us irrefutable proof that man is not naturally flesh-eating, but that his entire organism shows him to be frugivorous.

VIII.

Investigation into the Natural Regime of Man along the Lines of Comparative Anatomy and Physiology.

"All beings," says the naturalist Blanchard, "fill a definite rôle in the heart of Nature. If a plant tends to excessive propagation, worms and caterpillars supply a check. Caterpillars, again, may appear in too large numbers, whereupon ichneumons multiply in their turn and kill them off by millions. The phytophaga, or plant-devouring animals, which have an easy life, always tend to increase their numbers; the carnivora prevent this increase. . . . In another direction something quite different happens. The dead body of an animal lies on the ground, the soil is strewn with filth. Diptera and coleoptera deal with the body. Speedily larvæ swarm all over the frightful debris which they destroy or scatter about the ground. . . . Marvellous is the mission of these insects in fertilizing the soil by distributing the products of disintegration. . . ."

As we see, an admirable order, almost mathematical in its precision, governs the whole of Nature. Under the sway of their instinct, the animals obey laws, and the appetite of each is but the urge of Providence which thus inevitably directs it towards the mission it has to fulfil in the general scheme of the universe! . . .

It is thus evident that we find not only frugivorous and herbivorous, but also, and of necessity, carnivor-

ous animals. Still, the existence of the latter type cannot be regarded as complete justification of a flesh-eating diet. Carnivorous and necrophagous species exist, granted! This interesting fact, however, is but the manifest expression of a very special and necessary subordinate function, imposed on certain beings to ensure the equilibrium of the living world. It cannot be regarded as the providential indication that *animal flesh* is intended to serve as a food and that this dead organism is really a dietetic model.

Moreover, prolonged reflection is quite unnecessary for the discovery that man, the lord of creation, is not meant to perform any task of an inferior or degrading nature. The tiger and the raven, the shark and the whale, the worm and the maggot, the crab and the lobster, with all their congeners, most assuredly perform their duties too well for it to be necessary that human beings should help them in their work of restoring the balance of Nature by massacre and cleansing! . . .

If this evidence should not prove sufficiently striking, attend carefully to the following short analysis; it will suffice to convince you that man is neither carnivorous nor even omnivorous, and that he ought to abstain from flesh food altogether.

An animal's dentition indicates its regime as clearly as the structure of a machine indicates its rôle.

In the case of wild beasts the incisors are small. The enormous canine teeth are unsuited for mastication; they are called fangs or tusks and serve to seize and hold their prey. To cut up the flesh, however, the carnivora make sole use of their molars, which are sharp and edged like daggers. The points alternate from one jaw to the other and cut the flesh like a pair of scissors.

The incisors of the herbivora are long; the

canines, having been cast prematurely, are generally invisible. The molars, broad and flat, are used for grinding purposes.

The true frugivora, such as the apes, have a uniform dentition; the canines are well developed though too short to serve as fangs. The molars, flat and slightly mammillated, are suited for the mastication neither of flesh nor of grass; their purpose is to crush grains and fruit.

Now which of these classes does man most resemble, remembering that it is the molars alone that indicate the feeding habits of an animal?

Look inside the mouth of a dog or of a horse. Do your teeth resemble those of such animals? Certainly they do not. You have neither the wholly flat tooth of the equidæ nor the sharp cutting molar of the carnivora. Having neither the characteristics of the herbivora nor of the carnivora, you cannot be regarded as omnivorous and set between these two types of animals. This absurd transference of the arithmetical mean into anatomy would at least require that we deal only with beings of the same species.

Moreover, there can be neither ambiguity nor doubt whatsoever in the minds of those who are willing to be guided loyally by the teachings of anatomy. Man possesses most assuredly the dentition of the frugivora,[1] viz., 32 teeth consisting of 8 incisors, 4 average-sized canines, 8 small molars and 12 large mammillated molars. I repeat that there can be no doubt whatsoever: possessed of the jaw of the frugivora, man is himself frugivorous.

[1] From this comparison I draw no transformistic conclusion whatsoever. It would be absurd to conclude that man descends from the ape because he possesses the teeth of an ape. All I say is: like teeth require like food.

An investigation of the digestive tube also confirms this conclusion.

The human stomach is neither the small rounded pouch of the carnivore nor the enormous paunch of the herbivore. In volume and shape it resembles that of the frugivore. It is also well known that the digestive tube of the carnivore is four or five times as long as the body. Far more developed in the herbivore, the alimentary canal is twenty-five times the length of the trunk, whereas in the frugivore it is between ten and twelve times as long. Relying on these figures, authorities have affirmed that in man the intestine measures only five times the length of the body and that omnivorous man is almost a carnivore. They have committed an unpardonable and childishly simple error, forgetting that, in comparing man with the quadruped, he had to be treated as a quadruped and the size of the body should be compared with that of the trunk. In a man who is 1 metre 60 centimetres in height, the length of the body will thus be reduced to 75 centimetres; and as the digestive tube has an average development of 7 metres 5 centimetres, we obtain ten times the length,—i.e., the characteristic figure for the frugivorous regime. Thus, for the third time, basing my conclusions on anatomical teachings, I declare that man is a frugivore.

IX.

What we are to understand by food in general biology.

The foregoing justifications of a vegetable diet and a vegetarian regime, drawn from chemical analysis and from anatomy, suffice to prove the impregnable scientific foundation of vegetarian teachings. Still, this is not everything; we can

rise even higher and investigate that mysterious domain of laws and causes which governs the harmony of the world. Let us then appeal to general biology for the secret of the circulation of energy and matter throughout the living universe. There will be revealed to us the plan of that marvellous balance which exists between all beings. General biology will tell us the origin, the essential nature and profound mechanism governing the transmission of the forces of Nature to the various organisms. It will thus unquestionably define the true source of that alimentary force whereby the animal incessantly manifests its activity.

There is one general law that governs the whole universe: the principle of the conservation of energy. Wherever work is carried on, or energy manifested, we may seek for the origin of the energy, the way in which it is distributed and stored away, and the mechanism through which it produces functions and phenomena.

Essentially composed of matter, the living organism cannot evade the universal physico-chemical laws that govern matter. No being can create the energy at its disposal. The organism invariably borrows it from the cosmic environment, the common source of all energy. The solar rays in which things are enveloped assuredly have a powerful and beneficent effect on all beings. But this immediate action, however useful it be, cannot become the real origin of the force which the organism brings into play.

The animal never creates reserves of force; on the contrary, it rapidly destroys them in releasing the energy indispensable to its incessant activity. It is a transformer of energy; if you will, an admirable machine, but, just because it is incessantly consuming, analysing and destroying, it never synthesizes and stores away.

Now, this reserve of force and energy which the animal demands and utilizes without being able to produce, is what is commonly called food.

Note that, while the animal tends to be continually exhausting Nature's stores of food there must exist, as compensation, some mechanism intended to be continually repairing this nutritive reserve which should be inexhaustible.

This indispensable regeneration of food energy and matter, a formal condition of the existence of the living world, is the secret of the vegetable kingdom. Let us consult the physiological processes adopted by the green plant; they will give us the key to the problem of biological equilibrium which we are endeavouring to solve.

The air-organs of the vegetables contain green matter, chlorophyl, which possesses the remarkable property of absorbing the energy contained in sunlight and thus of constructing, out of the elements of the atmosphere and the soil, various chemical bodies—starch, sugar, fat, albumen—wherein it stores away the solar force in order to transmit it, in the form of foods adapted to their nature, to multitudes of living beings which, like man and the animals, are incapable of receiving energy direct from the sun.

This teaching of botanical physiology, so well formulated by Dumas the chemist, Claude Bernard the scientist and all modern biologists, clearly shows us how matter circulates. The green vegetable purifies and regenerates everything that the animal defiles, consumes or destroys.

How is it that the animal kingdom has not yet exhausted the vivifying springs of atmospheric oxygen? Seeing that there have existed for thousands of years beings that throw off waves of carbonic gas, why is it that the air has not yet

become unfit to breathe? Because the vegetable kingdom absorbs acid in proportion as it is being produced, and, being an inexhaustible source for the supply of oxygen, maintains unchanged the atmosphere in which we live.

Nor is this all. The animal in consuming the mass of food around it, must rapidly exhaust the reserve store and also encumber the neighbourhood with the excreta and impure products of the process of nutrition. The vegetable, however, has taken up all this waste matter from earth, air and water. By a power peculiar to itself, it has combined the carbon and nitrogen for the reproduction of food that is beneficent and savoury.

We now understand what a food really is, for we have seen its origin, nature and destiny. Issuing from solar energy through vegetable chlorophyl alone, the food which leads and directs external energy, in a form that can be assimilated, towards interior organic media and animal protoplasms, now appears to us in its true scientific light. What weight, then, have the caprices of fashion and the tyranny of routine in the presence of so manifest a truth? In vain are endless dissertations on the needs of omnivorous man, on the necessity of a so-called strengthening regime or on the objects of Providence which, it is claimed, destines the sheep and the cow for the knife of the butcher. Every objection disappears before these three laws which sum up the most important teachings of general physiology:

(1) A food is a substance suited for transmitting matter and cosmic energy to animal organisms, which are incapable of profiting by their contact with the common environment to gather energy therefrom.

(2) Vegetables alone, being supplied with chloro-

phyl, are capable of creating foods and food energy, because, alone destined to tap the springs of solar energy, they also alone have the capacity for chemical synthesis. Finally, they alone can renew the stock of matter and energy on which the animals draw.

(3) In a word, the true food, in its pure source, is inevitably vegetable.

As already announced, vegetarianism possesses all the force of a scientific truth loudly proclaimed by chemistry, physiology, anatomy, and general biology. We have explained the meaning of carnivorism and necrophagism in Nature by pointing out, along with Blanchard, the subordinate balance-distributing function which necrophagous animals unconsciously fulfil throughout the universe. Whilst uttering a warning against the temptation to look upon these facts as a lesson in carnivorism applicable to man, I have also proved the inadequacy and illogicality of a regime which regards the broken mechanism of a dead body as the source of life and strength, and its flesh as a food reserve. Everything has been demonstrated; nothing has been alleged without proof.

If conviction has not followed, then reflect and state your objections. Unlike most doctrines, scientific vegetarianism welcomes discussion as a means of affirming and spreading abroad the light of its truth.

CHAPTER III.

ILLNESS AND A FOOD REGIME.

"THE diseased organism" says Claude Bernard, "can obey no other laws than the healthy organism. . . . Normal and pathological anatomy and physiology obey the same laws, the study of which represents the scientific and theoretical part of medicine. Clinical medicine is the application of these processes."

This extremely affirmative teaching of the famous master of the *Collège de France*, who shows no hesitation in placing on an equality hygiene, medicine and physiology in one supreme biological conception, finds a particularly fruitful and fortunate application in the question of diet.

If, as I think I have already proved, the vegetarian diet is the expression of a truth based on general biology, chemistry and comparative anatomy, we may also affirm that it can never lead to error or misconception in the realm of therapeutics. On the contrary, it is manifest that the clinical justification of vegetarianism also contains its complete physiological justification. "You cannot have," adds Claude Bernard "both normal mechanics and abnormal mechanics"; meaning thereby that the same general principles of mechanics ensure the repair of a machine and also dictate the precautions to be taken for keeping it in good condition. How then would one dare maintain that the intoxication

and the nutritive overtaxing of an organism, known to be fatal during illness, can become beneficent or simply harmless in a state of health ! . . .[1]

Besides, this systematic separation of the two physiological orders, normal and abnormal, which is opposed to all logic, is calculated to mislead medical opinion, and, along with it, public opinion, as regards the usual cause of our troubles. People will not believe that the precepts of physiology involve problems of hygiene and of therapeutics. They are inclined to seek farther for morbid causes, in some extra-physiological domain, and refuse to accept responsibility for their sufferings. . . . Is not this tendency to irresponsibility becoming more and more one with the dangerous spirit of fatalism into which the exaggerated dread of microbes gradually throws people ? Ever looking without for the cause of our troubles, we come to forget that the permanent cause of disease is within ourselves. Instead of prudently regulating our regime according to the requirements of our delicate physical mechanism, we accept—because they are less disturbing to our habits of luxury or sensuality —erroneous pathological systems which, indulging our whims and releasing us from all responsibility, force us merely to take drugs or to disinfect our premises ! . . .

Error has roots too deep for it to be easily overcome. All the same, I should like in this chapter to rescue the reader, if I can, alike from a foolish terror and from a treacherous security, both of

[1] It is true that the forces of reaction possessed by a man in robust health will long prevail against repeated attacks of dietetic intoxication. Fatal in the case of a sick man, such intoxication can long be tolerated by a healthy organism. It does not follow, however, that it is favourable to such an organism.

which may lead him astray. It is my desire to inspire in him a certain sense of responsibility in the practical question of health and disease, to enable him to see what a powerful instrument he possesses in diet, an instrument of evil and death if he uses it without method, of life and fruitful activity if he will but apply his talents and strength to direct it aright. Finally, I wish to show that the question of diet affords the key to the enigma of health and sickness, of hygiene and of therapeutics! . . .

II.

Regime—Classification of the Morbid Influence of a Meat Regime.

The regime defines the use we ought to make of food to ensure balance of strength and fullness of life.

Consequently, a food regime is justified only if it supplies the entire range of material indispensable for restoring the tissues of the body and for maintaining the energy constantly being expended.

Now, of all this material—albumens, hydrates of carbon, fats, sweets and starches, phosphates and carbonates, salts of potash and soda, lime and iron —animal flesh supplies scarcely more than the first, i.e., albumen, which forms about one-fifth of its bulk, a trace of mineral, iron, phosphorus, and none of the strength-giving substances known as combustible or respiratory. On the contrary, it is largely laden with those excrements which chemistry calls extractive products.

It is clear that meat, of itself, is incapable of maintaining life, and that several kilogrammes of it

might easily be consumed without attaining to a nutritive balance of the organism. Ignorance alone can excuse the eagerness shown by this civilized society of ours in favour of a flesh-eating regime. Abounding in nitrogen, the food value of meat is yet very small : indeed, but for the exciting influence it possesses, its lack of nutritive qualities would long ago have been recognized.

The meat-eater, though absorbing a great deal, feeds badly and inadequately ; inevitably he falls into some serious morbid condition, through alimentary lack and excess on the one hand, through excitation and consequent depression on the other hand. In a word, a flesh diet leads to disease along four paths, which, in their entirety, absorb the greater part of the nosological domain. Indeed, this regime errs :—

(1) From inadequacy of mineral matter, a lack or *carence* which leads to anæmia and neurasthenia ;

(2) From excess of nitrogen, which favours acid and uric fermentations and rapidly leads to arthritis in its innumerable forms ;

(3) From excitation, engendered by the extractive products of meat which disturb nutrition and favour alcoholism ;

(4) From intoxication; which results from faulty digestive fermentation and ends in destroying the organism ! . . .

After successively developing these four points. which sum up the various pathological activities of a diet too rich in meat, I will draw certain hygienic and therapeutic conclusions.

III.

Inadequacy of the Flesh Diet—Anæmia and Neurasthenia.

If we were to analyse the ration of a family which prided itself on having a bountiful table, no doubt we should find it anything but well balanced. Nitrogenous foods and proteids figure largely, whereas respiratory matter, though far more important, plays but a very small part.

Is it not on plates of meat and fish that you exercise your digestion and use up your appetite? When vegetables, side-dishes and fruit appear in turn, it is too late; if you touch them, it is on principle, so that you may retain the right to say that, moderate in all things, you claim to feed on vegetables as well as on meat.

A meat regime, however, quite inadequate from the respiratory point of view, and very poor in mineral salts, is not sufficiently plastic and is manifestly incapable of making up for the losses of the organism.

Sufficient insistence has not been laid on the supreme importance of mineral substances in the physiological process. All the same, they are indispensable for the mechanism of nutrition and the repair of tissue.

The part played by mineral salts in living beings has recently been the object of important investigation. It is now known that all the liquids of the body are mineral solutions of fixed concentration, that the exchanges of matter necessary for vital activity are controlled by the unequal mineral concentration of the various humours, and finally that, by a proper ration, we must keep up this functional mineralization so that the nutritive activity may retain its perfect regularity.

This difficult research work has been summed up in special reviews by Winter, Maillard, &c. . . . who do not hesitate to declare that "the most mysterious phenomena of nutritive chemistry will assuredly have light thrown upon them by the properties connected with mineral solutions."

Mineral salts also play their part in forming and reconstructing the anatomical elements and the tissues of the body. For instance, it is generally known that iron is indispensable for the reproduction of the red corpuscles of the blood. A diet containing iron makes rich and generous blood; on the other hand, one that is poor in iron inevitably leads to anæmia.

Nor is the part played by phosphorus and phosphoric acid less important. Phosphorus enters into the constitution of the cellular nuclei. Now, these nuclei are none other than the innumerable centres of activity, the whole of which produce and synthesize our vital power. Phosphorus, however, is above all essentially the food of the nerves, nerve centres and brain, the perfect structure and functioning of which it helps to maintain. You have also noticed how important phosphorus and phosphates are coming to be regarded by doctors themselves. But instead of seeking them at their natural source, in a correct diet, the doctor administers them in the form of drugs when prescribing for a weakly child or a convalescent. You yourselves buy these phosphates at extraordinary prices from the chemist, without appearing to be aware that you may find them in abundance and without expense in a great number of foods.

Remember that cereals — especially barley and oats as regards iron; peas, lentils, wholemeal bread and most food plants as regards phosphorus—are far richer than meat in essential minerals.

Consequently, in the organism nourished exclusively on flesh, there is a serious lack of mineral matter, increased still further by the use of white bread which is both demineralized and dephosphated, and by the ridiculous folly of bleaching most of the green vegetables and then throwing away the water which contains the valuable mineral reserve of these foods.

Logically, have we any cause to wonder at the frequent cases of anæmia, neurasthenia and the many nervous disorders which increasingly afflict mankind? Is it admissible that we can starve the tissues for years, compel them from infancy to a prolonged deprivation of nutritive salts, and create, in a word, a state of mineral inanition, without the body being profoundly affected thereby? . . . Remember that these important tissues are blood and nerves, that they control the general nutrition of the organism—the former as chemical medium, the latter as a supreme co-ordinating agent—and that they can carry on their admirable work only if their properties are not injured in any way! . . .

In his fine work on *La Dysémie*, Dr. Lahmann unhesitatingly regards an inadequate mineral diet as at the root of nervous disorders. "It is impossible," he concludes, "to have a normal nervous system if during eight months of the year one eats only substances poor in nutritive salts, meat, white bread, potatoes, and during the four months of summer, vegetables and fruit containing nutritive salts; for the albumens and fats of the winter cannot combine with the minerals of the summer to produce a normal diet for the nervous system."

Dr. Jackson, of the United States, appointed to inquire into the causes of alcoholism in the thousands of cases entrusted to him, did not hesitate to attribute the entire evil to an erroneous

diet: "Never have I met," he said "a man accustomed to drink to excess who did not end by acknowledging that he was a glutton . . . food such as flesh does not nourish the nervous system . . . and yet the nerves tire as soon as . . . even sooner than . . . the muscles."

The inanition of blood and nerves engenders such a state of anæmia and neurasthenia, that the patient feels an imperious need for stimulants. He saturates his food with salt, vinegar, spices of all kinds, calls for increasing quantities of meat and *bouillon*, followed by coffee, tea, alcohol, and lastly a series of tonic and strength-giving drugs! . . . Such a regime will speedily bring the organism into a state of excessive fatigue, arthritism and intoxication. . . .

IV.

Exciting Effect of Meat. The Influence of Extracts. Alcoholism and the Regime of Excitants.

Meat is an excitant: a fact which no one will dare to question. Besides, is not this stimulating property the very thing sought after by the anæmic, the neurasthenic and the feeble of every category who indulge in a veritable debauch of animal flesh?

According to Dr. Jackson, there is no food which produces abnormal excitation of the nervous system to the same extent as beef. "When meat, after being eaten, penetrates into the blood, it produces on the brain and the ganglionary system of the heart a state of excitation which gives rise to great vital currents!"

What are the symptoms of this excitation? Dr. Huchard tells us, when he speaks of palpitation and irregular beating of the heart, breathlessness, &c.,

which follow the absorption of large quantities of meat.

This effect belongs more particularly to the soluble or extractive matter of the flesh. Indeed, the products of maceration of the muscle, extolled by Charles Richet in his zomotherapy, the gravy it is considered right to give to weak children, the comforting *bouillon* which certain persons in their weakness cannot do without, meat extracts which possess no nutritive value whatsoever—apart from the small proportion of mineral salts left in them by the meat—all obtain their stimulating properties from the impurities of the flesh itself, and the effect is all the greater when the muscular excreta are more abundant, as happens in the case of game run down by a pack of hounds.

Most certainly meats, *bouillon*, gravy and muscular extracts are excitants ; it is for this reason that they form the basis of the diet of our enfeebled generation.

Whence comes this passion for excitants ? It is the manifest expression of an organism that is anæmic, neurasthenic and shattered. It is an effect, not a cause ; for it is nervous degeneracy which in the first instance produces the desire for the excitant. A vicious circle, however, for the effect increases the cause, as the cause increases the effect ; degeneracy develops passion aud passion aggravates degeneracy, until the accelerated decline brings inevitable catastrophe both on the individual and on the whole race.

We mentioned alcoholism, so closely connected, as we see, with flesh-eating. As the result of innumerable observations at Danville in the United States, Dr. Jackson affirms that " to become sober in drinking, we must begin by being sober in eating," and that the alcoholic and the drunkard

find the germ of their passion "in their own homes, at their own tables." "A man takes to drink because of the state of his nerves which are starved by a diet too poor in nutritive salts." "Let the diet consist, on the other hand, of farinaceous food, fruit and vegetables, and the desire for alcohol is quickly replaced by abhorrence of it." The learned doctor adds, "The proof of what I state is seen daily in our Home . . . and this proof is indisputable, for the patients themselves affirm that they become sober, not from any moral consideration, but solely by reason of the regime they follow. "In a word, to do away with flesh-eating is to deal alcoholism a deadly blow! . . ."

I do not intend to enter upon a description of the frightful scourge of drink, nor to deal with the terrible evil engendered by the abuse of excitants. Nor will I set forth statistics showing the increasingly rapid progress of insanity and crime, infallible signs of moral and physical decline. Within less than thirty years the number of insane persons in France has almost trebled. Such things, alas, are but too well known.

A thing less well known, however, is that the frightful progress of this morbid surexcitation is clearly shown by the accelerated increase of the use of stupefying drugs. Within half a century, the French hospitals have increased the use of bromide of potassium a hundredfold. The annual consumption of morphia has risen in ten years from 200 grammes to 10,000 grammes. Within the same period, hydrate of chloral rose from 5 kilogrammes to 500 kilogrammes! Naturally, we must take into consideration the daily increasing use of anæsthetics in surgical and medical therapeutics. "This, however, neither explains nor diminishes the extreme gravity of so colossal an advance," says Deswarte in *Le Nevrosisme mortel.*

Indeed, it would appear as though a wave of heart-rending madness had suddenly swept over mankind. Unaware of the true causes of their trouble, feeble, anæmic and unbalanced persons, continually overcome by a false sense of irresistible hunger or need, find endless ways of satisfying the craving for excitants in stimulating meat-laden menus, aperitifs of every kind, the repeated use of brandy, coffee and tea. Can we wonder that such persons are filled with dismay when they happen to sit down to a meatless repast? Nor is their dismay assumed, for to them a beefsteak is as indispensable a stimulant as the glass of brandy to a man dominated by the passion for alcohol.

Above all, can we wonder at the awful effects of this morbid surexcitation added to the fatal influence of the stupefying drugs of which we have just spoken?

Think of the insensate struggle with the nervous system powerless to resist! Alternately excited and depressed, does it not remind one of a high-spirited steed which too heavy and clumsy a hand is brutally driving? Powerless between the exasperating whip and the arresting bit, he rears and prances, until finally, overcome by his struggles, he falls to the ground . . .

V.

Excess of Nitrogen in Meat—Acid and Uric Fermentations—Arthritism.

Thus an excessive flesh diet seriously affects the nervous system in two ways. On the one hand, lacking nutritive salts, it causes nerve degeneracy; on the other hand, laden with impure extractives, which overexcite and overwork without nourishing, it craves alternately after dangerous excitants and stupefying drugs.

I wish to mention the even more serious effect which excessive flesh eating produces in the organism from its excess of nitrogen. I refer to that general defect in nutrition, that morbid acidity of the humours a thousand times more dangerous and deadly than the most devastating epidemic, because it surreptitiously undermines the organism whilst affording an appearance of perfect health: the dreaded arthritism! . . .

Arthritism is characterized chemically by the acidity of the humours, which normally are neutral or slightly alkaline.

This excessive acidity is the result of profound digestive disturbance. To understand it, we must remember that digestion consists essentially of a fermentative transformation which converts the food into chyle, intended to enter the blood for the feeding of the various tissues of the body.

Normally this beneficent effect is brought about by the digestive liquids, the saliva, and the gastric, pancreatic and intestinal juices. Biological chemistry, however, demonstrates that every medium largely composed of nitrogen complicates and increases the fermentation of organic matter. If the diet introduces into the digestive canal an excess of nitrogen, especially of muscular nitrogen, we may straightway affirm that the process of chylification will be accompanied by various accessory intestinal fermentations, parasitic and acid, which will largely impair the normally alkaline contents of the intestines. This opinion is supported by facts that cannot be disputed. It is known that the number and variety of bacteria and microbes swarming in any medium indicate the intensity and diversity of the fermentative operations developing therein. The remarkable work by Gilbert and Dominici on this subject, presented before the Biological Society in 1894, should be

read. Analysing the contents of the digestive canal from the standpoint of the nature and number of the bacteria, these scientists demonstrated that in a diet rich in meat the bacteria reach the colossal number of 67,000 germs per milligramme of matter, whereas in a lacto-vegetable diet, at the end of four or five days, the number of these bacteria is no more than 2,000.

In certain cases, Gilbert and Dominici obtained so extraordinary a reduction of germs that it would be no rash thing to declare that the lacto-vegetable diet brings about complete asepsis of the digestive canal.

Thus it is irrefutably proved that, when saturated with nitrogen and with meat, the digestive canal becomes an admirable medium for the culture and development of all fermentations. And so there rapidly appear in the intestines, lactic, butyric, acetic, oxalic, valeric, caproic and other acids, all unhealthy and mostly infectious, which begin their destructive work in the digestive apparatus and speedily spread throughout the organism. But do not forget that these acid media will in turn engender and intensify the toxic fermentation of nitrogenous matter. Consequently the chemical process in the early stages of arthritism may be summed up in the following dual law :—

(1) The initial excess of nitrogen first creates the acidity of the medium; and (2) by reaction, the acidity of the medium produces toxic complication.

We will now follow the several phases of this progressive chemical morbidity.

The child, if born of slightly arthritic parents, early shows a slight tendency to acidity of the digestive juices, of the chyle, the blood and the humours.

Now, it is a well-known physiological fact that

this initial acidity stimulates the cells, the various anatomical elements, and increases their normal functions. Digestion and assimilation are thus very considerable from the beginning. Fat, chubby-cheeked, gluttonous, actually stuffed to the point of hiccough and vomiting, the child does indeed represent the baby of our dreams, the object of our admiration, the little angel we praise to the skies, as we flatter the foolish pride of the parents.

Nevertheless, the keen vigilant eye of the hygienist quickly discovers beneath the deceptive exterior of this excessive overfeeding—or rather on account of it—the symptoms of exciting and congestive acidity. Indeed, intestinal inflammation speedily shows itself, then increasingly frequent constipation, accompanied by formidable relapses. Suddenly, the fine rosy cheeks fade away and become covered with the waxen tints of athrepsia. And within a few weeks the child falls a victim to enteritis and diarrhœa! . . .

Fortunately, the majority of children make a stand. After a more or less serious crisis during which the organ has succeeded in regenerating its humours, the little one comes up smiling and is apparently all right again. Alas, the terrible trial, attributed to the process of teething, has not yet taught the parents their needed lesson. The time for weaning approaches; advantage will be taken of it to restore the pale weak child by means of a tonic and strengthening regime. He is given meat soups and gravies, and various exciting drinks—a regime demineralized and lacking in vitamines.

Thereupon one of two things happens. Either the tiny organism, crushed by the heritage of disease it has received from its ancestors, by the violence of the previous attack, by the use of an enervating diet, drags on a miserable existence in the grip of anæmia

or neuro-arthritis, or else the child still possesses sufficient excitability to resume, as the result of his tonic regime, the excessive appetite and apparent beauty which once again deceive the vigilance of the parents.

Thereupon the inflammatory process of acidity recommences its round. The superabundant gastric secretion enables the child to regain the sturdy appetite and digestion of his early infancy. He reaches the age of youth and is still a big eater, but inflammation begins to bring about new crises. There may be gastric trouble, accompanied by indigestion and pains in the back and loins. Chronic dyspepsia sets in, appetite is uncertain. As a young man he suffers from constipation, heartburn, unnatural thirst; his tongue is furred on waking. At night he is troubled with flatulence. Then follow headaches, drowsiness, palpitation, infallible signs that the evil is increasing.

The humoral trouble extends and becomes general. Irritated by acidity, the skin is covered with eruptions, herpes, nettlerash and eczema. This chronic congestive irritation shows itself in swelling of the tonsils, the tendency to pharyngeal growths. The body becomes extremely sensitive; the slightest irritant or chill produces a cold in the head, angina, neuralgia. . . Finally the inflammation reaches the muscles and joints, occasioning variable though at times terrible and fatal attacks of acute rheumatism accompanied by premature lesions of heart and blood-vessels.

Such is the sombre picture which synthesizes the first phase of arthritism, that of excitation and congestion. More serious still is the second phase, that of inadequate nutrition. The result of excess and overwork produced by the first, this phase does not manifest abruptly. For long it is complicated with

intermittent symptoms of functional exaggeration of the first phase; it ends by spreading over the entire adult organism which it prematurely wears out.

The cells lose their vitality. The nervous system having long since become enfeebled, most of the tissues have exhausted their reserve of vital energy. They deteriorate and degenerate in a way shown either by induration and sclerosis, or by adipose transformation and softening.

Let us see how the evil progresses.

The first tissue to be attacked is the liver. There is no organ that works so much as this great gland, with its many functions. Intended to hold in reserve the superabundant food, its purpose is principally to neutralize the toxic products of a faulty diet and digestion, before they are carried into the general circulatory stream.

As long as the liver is able to check the impurities of the intestinal canal, the organism remains well balanced. But when to digestive troubles are added some of the general symptoms above mentioned, sleepiness, suffocation, palpitation, herpes, eczema, rheumatism, &c., we may affirm that acidity and intoxication have reached the blood, and that the liver is henceforth powerless to arrest the increasing onrush.

This doctrine of Glénard emphasizes a special morbid state: hepatism, an inevitable medium condition between nascent digestive arthritism and the true arthritic diathesis which spreads all over the organism. Indeed, prolonged hepatism quickly produces that general morbidity so well described by Bouchard when dealing with diseases caused by a nutritive slowing-down process. This process, which is the index and the consequence of a premature wearing-away, prevents the body from properly utilizing the entire mass of digestive products

of unhealthy composition which the intestines still pour forth without the liver being able to regulate the flow or counteract the resulting impurity.

"In presence of this overflow," says Dr. Maurel, "the body defends itself as well as it can." Sometimes it deposits, in the form of fat, the excess of the food it can no longer transform or burn up entirely, the result being obesity; at other times, unable to use the sugar which the liver cannot deal with, it allows it to escape in considerable quantities by way of the urine. The obese and the diabetic have one common morbid symptom, a strongly acid urine: an exact reflection of the general acidity of blood, humours and tissues. Instead of forbidding sugar and starchy foods—which is but a childish and illogical thing to do—we must "regenerate the soil," as Dr. Pascault expresses it, by suppressing nitrogenous food which generates acids, i.e., flesh meat, and also those products which impede nutritive combustion, i.e., alcohol.

It is worthy of note that resistance to acid poisoning, considerable in carnivorous animals, is feeble in herbivorous and frugivorous ones, and consequently in man. This is due to the fact that ammonia, which is capable of neutralizing the acids of the body and is abundant in the carnivora, is produced but slightly in the herbivora and frugivora and in man.

Amongst the products which spread throughout the body, after forcing their passage through the liver, must be mentioned a particularly dangerous acid excretum, which the use of meat always produces: uric acid. Spread throughout the organs of the body, it becomes the origin of numerous morbid forms, typically gout. The presence of uric acid predisposes to gouty rheumatism, sciatica, urinary gravel and nephritic colic, bilious attacks and

hepatic colic. Such is the abridged list of arthritic forms at the second and third stages of the morbid process.

We have not yet mentioned the serious and fatal forms. We need imagine only one further step in the process of disorganization to arrive at a state of utter deterioration of the most important tissues.

As regards the mucous membranes, we have the final stage of inflammation along with gastritis, ulcers or cancer. As regards the blood-vessels, we have induration, the serious lesion known as arterio-sclerosis, the consequence of prolonged inflammation.

If this sclerosis affects the liver, we have hepatic cirrhosis and dropsy. If it affects the kidneys, we have nephritis, Bright's disease, kidney weakness. If sclerosis affects the vessels of the heart, it produces *angina pectoris*; if it affects the medulla and its vessels, it results in the various myelites and locomotor ataxia. It may also lead either to softening of the brain or to hæmorrhage with hemiplegia.

These are the final manifestations of arthritism. Does not this fourth and last deserve to be called the senile phase? The expression would be correct if these final and fatal lesions had any chronological relation to old age, properly so called. In reality, this fourth stage simply defines physiological senility. Remembering Dr. Lagrange's formula: "A man is as old as his arteries," we see that physiological senility of the fourth arthritic phase, sometimes a very premature one, may take place at thirty or forty years of age.

It will be more correct to define this fourth phase as kidney weakness, for this weakness is the criterion of the complete decline of an arthritic. From this moment the worst may be expected. Is it not evident that the impermeability of the kidneys will

keep the body in a state of continual auto-intoxication which will speedily kill it ?

This will be proved in the next chapter. I cannot however end this investigation into the arthritic process without summing up my conclusions as follows :—

(1) It is the excess of nitrogenous food, especially of meat, that constitutes the essential origin of the arthritic process.

(2) The arthritic process comprises four main phases :—

The digestive phase shown by a state of pronounced congestion ;

The phase of hepatic weakness shown by the generalization of morbidity ;

The phase of diathesic action shown by the premature and rapid wearing away of the organs ;

The phase of kidney weakness shown by the fatal disease of tissues and final intoxication.

This is by no means a complete study of arthritism ; all I have done is to deal with the most frequent manifestation of this serious predisposition, resulting from diet excesses and particularly from the abuse of meat.

VI.

Toxic Properties of a Flesh Diet ; Fatal Consequences of Kidney Weakness.

We have now come to the most serious effects produced by an excessive flesh diet : its toxic influence. In his famous lectures delivered in 1890 at the Hôpital Cochin, on the lacto-vegetable diet in therapeutics, Dujardin-Beaumetz, analysing the causes of intoxication, relates them to three sources. He first mentions the poisons of life, those

resulting from the regular play of the organism (Gautier's *Leucomaïnes*) ; then the poisons that come from the digestive canal, the ptomaines, which, as we have seen, arise from an intestinal chyle containing too much nitrogen and acid, through a "series of vicious fermentations." Finally, the third cause of intoxication is found in diet, for "as man feeds mostly on meat," says Dujardin-Beaumetz, "he introduces into his body a certain number of cadaveric alkaloids by way of his food."

We may well accept from the mouth of so great an authority, well known for his tact and moderation, what might be regarded as bad taste on the part of anyone else. At all events, we should remember that a flesh diet is doubly toxic, both as regards the poisons it actually contains and as regards those whose formation it determines.

Amongst these food poisons must be mentioned those nitrogenous excretions named purins : purin strictly so called, oxypurin or hypoxanthine, dioxypurin or xanthine, trioxypurin or uric acid. The foods that contain most purins are sweetbread, liver, viscera and meat. The legumes (haricots) contain small quantities of it. The caffeine of coffee and the theobromine of chocolate are methyl xanthines, sources of uric acid in the body.

Nothing more clearly proves the intensity of this toxic property than the following curious experiment known to all physiologists as Eck's fistula. Here it is :—

The blood which returns from the digestive canal along the several veins of the intestines goes first to the liver. This gland stores up a portion of the matter absorbed, on the one hand ; on the other, it exercises its marvellous defensive rôle by arresting the poisons which, on leaving the

digestive canal, threaten to invade the entire organism. Suppose, in the case of an animal, a dog for instance, that we prevent the blood from crossing the liver, and, along a derivative tract, force the intestinal blood to fall direct into the general circulatory stream. Then we have realized Eck's fistula which suppresses the regulating and antitoxic function of the liver. Now listen to what Arthus says in his *Eléments de Physiologie*, the classic treatise on physiology, and one, I can assure you, that is anything but partial to vegetarianism:—

"The animal was gentle and obedient; following on Eck's operation he became ill-natured and obstinate, then weak and sleepy, his gait is irregular and ataxic; later on, he falls a prey to extreme agitation. . . Lastly, he manifests clonic and tetanic spasms, alternating with coma. The totality of these phenomena constitute a crisis. One can bring about at will a crisis in an animal subjected to Eck's fistula; all that is needed is to give him a meal rich in ordinary flesh or in powdered flesh."

The experiment always leads to the same results; an animal fed on milk and vegetable soup survives; fed on flesh, crises of terrible intoxication supervene and he dies! . . .

This affords an evident and irrefutable proof of the toxic effect of meat. The result is extremely suggestive and calls for serious reflection.

But then, you may say, *we* are not suffering from this precious Eck's fistula of yours, and fortunately our livers are free to carry on quietly their indispensable defensive task. In my opinion, you are grievously mistaken! . . . Unless you are careful, the pathological conditions just described speedily appear. And this is perfectly comprehensible. In the first place, the defence will be effective only if

the attack is not too violent ; in other words, unless you watch your diet carefully, your liver, though still very sound, will not be able to arrest the poisonous flood which penetrates it ; it will allow a portion of it to pass, but intoxication will set in. Besides, the overwork to which you subject the liver through food indiscretions will bring about, as already stated, functional weakness and premature wearing away of the organ. Here then, unknown to you, is gradually taking place Eck's fistula. It will be almost complete when the circulatory disorganization produced by progressive intoxication has completely imperilled the normal working of the hepatic circulation.

Whatever you do, you will not evade these inevitable consequences of the enfeebling process created by errors in diet. Premature intoxication will carry through its baneful work. The liver was the *bulwark* of the organism ; everything—even the impossible—should have been attempted to prevent its downfall. Now, the door is wide open ; all resistance to invasion is of no avail.

The liver exercises its wonderful defensive power against intoxication owing to its property of transforming uric acid, purins, and ammoniacal salts into urea, the toxic power of which is far weaker than that of the purins. When Eck's fistula is practised on an animal, the amount of urea in the urine considerably diminishes, whereas the proportion of uric acid and purins is increased fourfold—sometimes even tenfold.

However, there is still one hope left. The kidneys are a sort of filter, through which, along with the urine secreted, the blood most speedily frees itself from the poisons which impregnate the organism. In a final defensive effort they will hurl across the frontier the enemy who always enters in serried

ranks. The effort, all the same, will be practically ineffectual unless you keep watch over your diet. The kidneys, in their turn overworked, disorganized, indurated, and sclerosed, powerless like the liver, will quickly leave intoxication master of the situation. Then, having come to the fourth phase of arthritism, that of kidney weakness, in which the kidneys have lost their permeability and power of elimination, the organism sinks into the distressful state of anuria. Then the symptoms of intoxication multiply. Woe to the man who does not see that his final chance of recovery lies in the radical suppression of all food capable of producing the slightest trace of poison! . . . Unless he understands this, he is hopelessly lost!

The symptoms experienced are those which Dr. Huchard has so well grouped together in *botulism*—sausage-poisoning. There is intense dyspnœa or painful breathing, muscular weakness and visual deterioration; above all, great circulatory disturbances, sudden pallor, syncope, formication and vertigo. Deterioration of the blood-vessels and the kidney weakness make these symptoms particularly grave. Indeed, amongst the troubles produced by food poisons is excessive tension of the blood in the blood-vessels. The kidneys being too impermeable to relieve the circulatory apparatus, the small arteries of the brain, already deteriorated and friable, burst beneath the blood pressure, handing over the entire organism to the onslaught of cerebral hæmorrhage.

To this must also be added the symptoms of botulic intoxication, of which Dieulafoy, Huchard and Bohn have given so many descriptions. One only will suffice to show the extreme seriousness of a somewhat excessive flesh diet in those whose liver and kidneys are affected. One of these cases, com-

pletely cured eighteen months previously by a lacto-vegetable diet recommended by Huchard, once unfortunately conceived the idea of entering a famous restaurant in Paris, where he yielded to the temptation to eat lobster and game. That very night he had terrible difficulty in breathing, and the following morning was covered with scarlatiniform eruptions, which appear so frequently in food intoxication. Within forty-eight hours he died of dyspnœa.

This fatal ending might have been foreseen. In any one gravely afflicted with kidney weakness, a complete cure is impossible. All the same, it is quite possible for him to live many happy years if he will avoid all food intoxication. But he must never forget that a meat diet will more certainly inflict death upon him than it did in the case of the dog on which Eck's fistula had been operated; for, in the latter case, the kidneys were still working, whereas in our patient the organ is powerless.

Let me end this chapter with an important conclusion, formulated by various authorities, and recently published by the *Académie de Médecine.* Cases of sudden death multiply; they are generally attributed to embolus or aneurysm. We have mostly to deal with food poisoning in an organism where liver and kidneys are weak. Are you not startled at the thought of the numberless lives destroyed as the result of a blind and silly prejudice? . . .

VII.

The Principle of Hygiene and Therapeutics by means of a Lacto-Vegetable Diet.

We need only become imbued with the above-mentioned teaching to be convinced of the many and fruitful applications it finds in the dual problem of hygiene and therapeutics.

By carefully watching over the diet from birth onwards, we may partially remove the burden of disease a child has inherited.

By early substituting for meat, food that is rich in nutritive elements, and that contains the right nutritive salts, we endow the body with stronger tissues and stouter nerves, and keep it free from anæmia and neurasthenia. Thus we avoid awakening the craving after excitants—a fatal passion calculated to pervert and rapidly destroy the balance of the nutritive mechanism in general. By reducing the amount of alimentary nitrogen, chiefly muscular, and obeying the wise conclusions of Gilbert and Dominici, we obtain, with a lacto-vegetable diet, the almost complete asepsis of the digestive canal. Thenceforth, the dangerous acid process of the arthritic and uric diatheses, with their successive phases of congestion, overwork, and inevitable disorganization, are either arrested or singularly retarded. Maladies of digestion, gastro-intestinal inflammation, with constipation, appendicitis, typhlitis, and peritonitis, diseases of the liver, tendencies to inflammation of the mucous membranes, glands, muscles and joints, the various manifestations of gout with nephritis and gravel, diabetes and obesity, the progressive diseases of the nervous system, heart and blood-vessels, the functional weakness of liver and kidneys; finally, serious intoxication and

blood hypertension, which produce so many sudden deaths: all these diseased conditions, the bane and horror of mankind, may be considerably diminished, if not altogether eliminated, by a correct diet.

It is impossible for me to state here the fully detailed therapeutic indications in which a diet regime plays a fundamental part. Suffice it to note that Dieulafoy, Bouchard, Huchard, Robin, Lucas-Championnière, Dujardin-Beaumetz, to quote only the greatest of authorities, have regarded diet as the foundation of all therapeutics. In his famous series of lectures at the Hôpital Cochin, Dr. Dujardin-Beaumetz generalized the therapeutic rôle of the vegetarian regime. Reviewing the treatment of the various digestive troubles, dyspepsia, gastro-enteritis, constipation and diarrhœa, he concludes as follows: "A vegetarian regime promotes abundant excreta in cases of constipation, and has an equally beneficial influence in cases of diarrhœa, calming the irritation and inflammation of the intestinal mucous membrane . . . . . ."

The famous professor is no less affirmative as regards the uric diathesis, gout, rheumatism, arthritis, heart disease, arterio-sclerosis (that *rusting* of the arteries), and, with Huchard, he lays stress on the extreme danger of a flesh diet when intoxication can no longer be dealt with by the liver nor removed by the kidneys.

True, in 1890, Dujardin-Beaumetz forbade those suffering from diabetes to partake of sugar, farinaceous foods, fruit and even milk; he recommended Bouchardat's diet based on meat and gluten bread. At the present time, however, we may protest against this illogical formula, the best result of which is to wear away still more, by excess of nitrogen, an already overworked liver. G. Sée, Bouchard, Lépine, Lécorché, some years ago began to refute the

authority of Bouchardat, and now several authorities, particularly Mossé, write in scientific reviews learned clinical and experimental articles on the improvement obtained by diabetic patients subjected to a regime of potatoes.

In a word, whilst always beneficial and never dangerous, calculated to relieve or remove the most serious evils, the vegetarian regime is one of the most powerful curative agents possesssed by man.[1]

[1] In his fine work on *Alimentation* (Paris, Masson, 1908), A. Gautier, one of the greatest authorities on biological chemistry, in concluding an investigation into vegetarianism, expresses himself as follows : " This regime is one that may be accepted rationally and extolled by those who are pursuing, as an ideal, the creation and education of races that are peaceful, intelligent, artistic, and yet prolific, vigorous and active." What greater appreciation could one desire !

CHAPTER IV.

FOOD REGIMES IN SOCIAL AND ECONOMICAL PROBLEMS.

I.

The Economic Problem and the Reduction of Expenses.

ECONOMIC questions are assuredly amongst those which most concern the minds of men. Need we wonder at it? With a paltry wage or a very modest salary, the head of a frequently numerous family is compelled to make income and expenditure balance each other and at the same time to ensure the material conditions of life for those dependent on him whilst providing against the dreaded possibilities of illness or a stoppage of work and the serious losses which such eventualities bring in their train.

Naturally the solution of this problem has ever been regarded as the gravest of all the anxious cares that beset man and society: the social question has at all times claimed the attention and consideration of enlightened and generous natures. Seldom, however, have such preoccupations assumed the grave character they manifest in these days.

It is not for me to offer the solution of a problem into which so many factors enter. Still, may I be permitted to remark that the principle of an increased wage does not appear as though it could bring any positive and lasting relief or remedy for the social

evil, and that its application would probably prove disappointing. "It is indisputably true and a fact of daily observation," says J. Roux, an eminent legal authority, "that all reforms which tend to increase the positive resources of the people—such as the increase of wages—are incapable of definitely ensuring a state of contentment. No sooner have wages been raised all round than the various commodities of life will be raised simultaneously, and the evil will remain unchanged . . . . . nothing but the reduction of expenses can be of lasting and unequivocal efficacy. And this will be brought about by the suppression of false needs; a suppression that procures happiness by putting a stop to all regret at being unable to satisfy their needs, and I will add that such reduction of expenses, in contradistinction to increased resources, remains entirely within the power of all who are willing to practise it . . ."

I do not think this opinion can be seriously challenged. Just consider the rapid transformations which, in less than a century, have affected the manners and customs of the lower and middle classes. Alongside the foolish and ridiculous vanity that impels to luxury and extravagance has grown up the thirst for enjoyment of every kind! Eccentricities of table and toilet, artificial needs and bad habits have doubled or trebled, perhaps decupled the main items in our expenditure.

Is not the sensuality which so many people introduce into their diet extraordinary, almost cynical? Wine and cider, coffee and liqueurs, harmful or at least useless excitants, have a definite place on the tables of even the humblest families. In addition, meat and game, and the products of the pork-butcher's shop, partaken of for the mere pleasure of the palate and because of a ridiculous prejudice,

quickly run away with wages which otherwise would have proved quite adequate.

Such food demands, contrary to the sober habits and customs of former generations, have largely contributed to bring to its present acute stage the economic and social crisis from which we are suffering.

At a time when the cry of alarm and distress threatens to raise up a storm of foolish utopias, it is my firm conviction that useful work may be done by proving that a return to the practice of a simple regime—the lacto-vegetable and vegetarian diet—already demanded by physiology, hygiene and therapeutics, is still capable of bringing to the social evil a condition of welcome relief and a breathing space which economists have sought for in vain.

II.

The Cost of Flesh Food—The Price of the Restoration of the Losses of the Body in Flesh eating, Semi-Flesh eating, and the various Non-flesh Foods.

Diet has a dual object: the restoration of the losses of the body and the upkeep of its reserves of energy. Thus there are two great categories of food which the chemist Liebig distinguished by the names of plastic and respiratory. In the second chapter I stated why this classification, if confusion is to be avoided, should be replaced by chemical systematization which informs us that whatever is eaten may be reduced to four classes of compounds: albuminoids, or substances containing nitrogen, fats, hydrates of carbon and mineral matter.

Every complete diet, i.e., one calculated to main-

tain life, should contain these four things in the right proportion.

Authorities have fixed the "repose" diet in the adult man as follows :—

Albuminoids - - -	120 grammes
Fats - - - -	50 ,,
Hydrates of carbon -	400 ,,

In accordance with the explanations given in the preceding chapter, this proportion of nitrogen is too high, and may easily be reduced by more than one-third.

The chapter on Physiology contains an analysis of the principal foods that are used. To this table the reader may refer for the main data of the following analysis.

I start with the observed fact that the adult Frenchman daily absorbs an average of 120 grammes of albuminoids and an energy ration of 2,600 calories; without here discussing whether this ration is too high, I propose to find out the cost of the nitrogenous restoration of our losses in the different regimes. Then I shall show what expenditure is required in keeping up the bodily strength.

Let us seek the cost of the kilogramme of albumen in the different foods.

A kilogramme of flesh contains only 180 grammes of albumen, i.e., $5\frac{1}{2}$ kilogrammes of lean meat must be purchased to obtain 1,000 grammes of albumen. Previous to the war, boneless meat cost an average of 2 francs 50 centimes per kilogramme; now it costs about 4 francs 50 centimes. Thus, to obtain 1,000 grammes of albumen, with meat, it was necessary to spend 13 francs 75 centimes; now the cost is 25 francs.

But when you buy 25 francs worth of lean meat, you have just your 1,000 grammes of albumen,

and nothing more. Whereas 8 francs spent on haricots, or 5 francs 75 centimes on bread, or 19 francs 40 centimes on milk, bring you, in addition to the 1,000 grammes of albumen, a considerable quantity of starch or fats, thus greatly diminishing the net cost of the albumen.

Let us take two examples, milk and bread :—

Milk.—According to the composition tables 27·7 litres of milk are needed to supply 1,000 grammes of albumen ; at 70 centimes per litre, this comes to 19 francs 40 centimes. But this amount of milk also gives 1,100 grammes of pure cream which, at the present price of butter, is worth about 10 francs, as well as 1,500 grammes of sugar of milk, or lactin, which, at the price of ordinary sugar, is worth 2 francs 50 centimes. The cost of milk albumen, after deducting cream and lactin, is thus reduced to 6 francs 90 centimes per 1,000 grammes. Before the war—price of milk 30 centimes per litre ; of butter, 4 francs the kilogramme—milk albumen cost scarcely more than 2 francs 50 centimes per 1,000 grammes.

Bread.—11½ kilogrammes of bread at 50 centimes per kilogramme, i.e., 5 francs 75 centimes must be expended to obtain 1,000 grammes of albumen, but this amount of bread yields also 6 kilogrammes of starch. By reason of the special importance of albumen, let us give it a price double that of starch, making 6 kilogrammes of starch equal in cost to 3 kilogrammes of albumen. Then three-quarters of the total cost of the bread is attributed to the starch, and only one quarter to the albumen. 1,000 grammes of albumen thus cost only one quarter the total price of the bread, i.e., 1 franc 45 centimes. Before the war, with the kilogramme of bread costing 40 centimes, the 1,000 grammes of albumen came to 1 franc 15 centimes.

Instances might be multiplied. The adjoining table, which groups together the most interesting figures, proves that, both before and during the war, the albumen of meat is far more costly than that of milk, cereals, legumes and bread. Before the war, the albumen of bread was one-twelfth the price of that of meat: in war time, it cost one-twentieth the price.

COST OF 1,000 GRAMMES OF ALBUMEN IN THE VARIOUS FOODS.

	1913		1918
Lean meat (beef, mutton, veal)	13 to 14 fr.	...	25 fr.
Fowl	15 to 20 fr.	...	30 to 35 fr.
Rabbit	15 fr.	...	22 fr.
Lean fish	15 fr.	...	30 fr.
Eggs	12 fr.	...	22 fr.
Milk	2 fr. 50 c.	...	6 fr. 90 c.
Cheese (Gruyère)	4 fr.	...	12 fr.
Legumes (lentils, haricots)	1 fr. 50 c. to 1 fr. 75 c.	...	4 fr. to 4 fr. 50
Bread	1 fr. 15 c.	...	1 fr. 45 c.

Nothing is now simpler than to calculate the restoration in nitrogen of the losses of the body in the regimes. We will examine in succession the flesh, the semi-flesh and the non-flesh diets.

However eager he may be for animal flesh—fish, shell-fish, fowl, game, butcher's meat, ham and pork,—man cannot be wholly carnivorous. Indeed, is there a single animal species which is strictly carnivorous?

Still, I give the name to the man who, seeking the whole of his ration of nitrogen in animal flesh, contents himself with a little bread and a few vegetables and devours large quarters of roast beef and venison along with huge slices of meat-pie. Remember, I have no objection to so robust an appetite which, after all, may be perfectly legitimate. But that is not the question with which we are dealing. We will not even inquire if this regime is dangerous;

a matter already considered. For the present, I wish simply to denounce the expense of such a diet and see how it may be avoided.

The flesh eater of whom we are speaking absorbs daily from 600 to 700 grammes of meat which exactly supply him with the nitrogenous ration of 120 grammes required by the authorities for repairing losses. In pre-war times, this cost him from 1 franc 40 centimes to 2 francs. At present it costs him about 4 francs.

The semi-flesh eater contents himself with one plate of meat per meal. Consuming daily an average of 275 grammes of animal flesh, he finds the rest of his albumen ration in other foods, especially in bread. Before the war, the expense of his nitrogenous ration was 60 centimes in meat, 10 centimes in vegetable albumen : altogether 70 centimes. It now comes to 1 franc 50 centimes.

We pass to the non-flesh diets.

A *vegetalian* who consumed only vegetable albumen at 1 franc 50 centimes per kilogramme effected his daily nitrogenous restoration of 120 grammes for the trifling sum of 20 centimes.

During the war, owing to the restriction of bread and the absence of meat-pies, as he was obliged to make greater use of the legumes, the *vegetalian* expended about 30 centimes on his nitrogenous ration.

The expense is scarcely greater in lacto-vegetable vegetarianism where we find about 40 grammes of albumen in a litre of milk. Formerly we had to reckon 10 centimes for vegetable albumen, and 15 centimes for animal albumen : a total of 25 centimes. The total is now 50 centimes or 55 centimes.

Finally, for the fruitarian of our climate, the nitrogenous restoration based on an albumen which

at present reaches 5 francs 50 centimes per kilogramme, requires the slightly higher sum of 65 centimes.

Such is the expenditure necessary for the nitrogenous restoration of expenditure in each regime:

		1913	1918
Flesh-eating regime		1 fr. 70 c. ...	3 fr. 50 c.
Semi-flesh-eating regime		70 c. ...	3 fr. 50 c.
Non-flesh-eating regimes	Fruitarianism ...	50 c. ...	65 c.
	Lacto-vegetal vegetarianism ...	25 c. ...	50 c.
	Vegetalism ...	20 c. ...	30 c.

These figures need no commentary. In normal times, the *vegetalian* can economize daily, in the nitrogenous ration alone, 1 franc 50 centimes over the flesh-eater, and 55 centimes over the semi-flesh-eater; the vegetarian also effects a daily economy of 50 centimes over the partaker of a mixed diet.

Nor is this all. Remember that the simplest lesson in alimentary physiology teaches us that the daily nitrogenous ration can—and even ought to—be reduced to 50 or 60 grammes. Flesh-eaters ignore or else reject this teaching; but non-flesh-eaters who practise it succeed in reducing still further the expense of their nitrogenous reparation by one-half or one-third, thus spending no more than 20 centimes or 25 centimes per day on their albumen ration.

It might be possible to extend this economic investigation to the food restoration of the man who daily engages in hard physical work. I simply remark that if we accept the figures of Gasparin for a robust British workman, or those given either by Hirn or Gautier for the French workman, there would be needed an average of 500 grammes of meat and 1,000 grammes of bread, i.e., a daily expenditure of 1 franc in animal albumen and of

10 centimes in vegetable albumen.[1] On the other hand, the vegetarian worker—for instance, the metallurgist in Mr. Hill's works—could procure the same total albumen ration for 30 centimes; but as he knows that the nitrogenous ration ought not to increase with work, he is in reality satisfied, like the man in repose, with 20 centimes of albumen, thus effecting a daily economy in nitrogen of 2 francs over the flesh-eating workman. Before the war, the economy effected by the vegetarian workman on his nitrogenous ration alone was nearly a franc.

III.

Cost of the Total Energy Ration.—Value of the Calorie in the Various Elements.—Expenses required by the General Nutrition of the Body, according to the Nature of the Regime.

The nitrogenous ration for restoring expenditure into which an economical investigation has just been made in the various regimes, represents but a fraction of the total ration. Indeed, the organism must further absorb a fairly large mass of food to obtain the source of energy which it daily expends. Thus we shall obtain a more complete and striking idea of the economic value of various regimes by first calculating the energy contained in the chief foods and afterwards the number of calories obtained for 1 franc with each of them. Then we shall see how extraordinary is the economy realized by the vegetarian regime.

It is well known that the total energy of a food

[1] At present this would be an expenditure of 2 francs for animal albumen alone, and of 15 centimes for vegetable albumen! . . .

is gauged by the number of calories—units of heat—which its combustion releases. Let us then calculate the calories produced by the principal articles of food.

According to the calorimetric experiments of Rubner, 1 gramme of combustible food ingested, in combustion with the oxygen in a living being, releases the following quantities of heat:—

Albumen	4·1 calories.
Hydrates of carbon (sugar and starch)	4·1 ,,
Fats	9·0 ,,

It follows that the kilogramme of meat, which contains only 170 grammes of albumen and 50 of fat, develops a mean energy of 1,180 calories; whereas wheat, which contains 146 of albumen, 12 of fat, 679 of starch yields as much as 3,500 calories! . . . By extending this calculation to the principal articles of food, it is easy to draw up a table of the energy contained in 1,000 grammes of each of them:—

Foods	Energy contained in 1 kilogramme
Lean meat	1,150 calories
Fat meat	1,800 ,,
Milk	730 ,,
Eggs	1,460 ,,
Butter	7,580 ,,
Wheat	3,500 ,,
Maize	3,610 ,,
Rice	3,510 ,,
Lentils	3,690 ,,
Potatoes	902 ,,
Fresh grapes	644 ,,
Dry grapes	2,500 ,,
Dried almonds	6,000 ,,
Dried figs	2,764 ,,
Bread	2,718 ,,
Cheese (Gruyère)	3,732 ,,
Chocolate	4,870 ,,
Bouillon (one pound of meat per litre)	30 ,,

The energy value of almonds and oleaginous fruits—nuts of various kinds—is five times greater than that of meat and almost reaches double that of corn and rice. Lentils and legumes come second, with Gruyère and various cheeses; then come the cereals, the food value of which is double that of eggs and treble that of meat. Bread affords twice as much energy as does animal flesh, which latter is but slightly superior to milk and fresh sweet fruit. It should also be remembered that milk, in contra-distinction to meat, is a complete food; that dairy produce, with fruit, used in place of beverages, can be absorbed in far greater quantities than meat, and that, in any case, it is twenty times more nourishing than *bouillon*.

According to this table, and taking into account the average cost of foods, we can readily calculate for each one of them the amount of energy we purchase for one franc.

For instance, as regards lean meat (trimmed and without bone) we know that it costs at present 5 francs per kilo, and gives 1,150 calories. With one franc's worth of lean meat, therefore, we buy only 230 calories!

1,000 grammes of bread, worth 50 c., represent 2,718 calories. One franc's worth of bread, therefore, supplies us with 5,436 calories . . . . . How great a difference!

The following table indicates for each article of food, at the average cost for the various districts, the amount of energy purchased for 1 franc. We place in parallel columns the figures for the years 1913 and 1918.

Now compare this table with the former and you will note the extraordinary inversion to which food energy may be subjected according as it refers to the weight or to the price of the food in question.

AMOUNT OF FOOD ENERGY PURCHASED FOR ONE FRANC.

Food	1913 Cost per kilo	1913 Energy purchased for 1 fr.	1918 Cost per kilo	1918 Energy purchased for 1 fr.
Lean meat	3 fr.	380 calories	5 fr.	205 calories
Moderately fat meat	1 80 c.	1,000 ,,	4	450 ,,
Fowl	3	500 ,,	6	250 ,,
Rabbit	2 50	560 ,,	5	280 ,,
Lean fish	2	390 ,,	4	195 ,,
Eggs	2 50	585 ,,	5	290 ,,
Milk	0 30	2,435 ,,	0 70 c.	1,040 ,,
Corn (wheat)	0 40	8,750 ,,	0 50	7,000 ,,
Rice	0 80	4,380 ,,	3	1,160 ,,
Bread	0 40	6,800 ,,	0 50	5,440 ,,
Potatoes	0 20	4,510 ,,	0 40	2,250 ,,
Lentils	0 60	6,150 ,,	3	1,230 ,,
Haricots	0 60	6,150 ,,	2 25	1,640 ,,
Chestnuts	0 50	3,280 ,,	1	1,640 ,,
Fresh grapes	0 80	805 ,,	1 20	536 ,,
Dried grapes	2 80	890 ,,	8	310 ,,
Dried figs	1 20	2,300 ,,	2	1,380 ,,
Almonds	3 60	1,660 ,,	3 60	1,660 ,,
Butter	3 60	2,190 ,,	10 40	728 ,,
Margarine	2	3,790 ,,	4 20	1,800 ,,
Oil	2 40	3,510 ,,	4 90	1,720 ,,
Chocolate	2 40	2,030 ,,	4 60	1,060 ,,
Preserves	1 40	2,000 ,,	3	930 ,,
Sugar	1	3,973 ,,	1 70	2,337 ,,

This latter point of view is particularly interesting, for we consider our meals not only by the amount our stomach can tolerate but also by the amount of money at our disposal. Still, it is evident that the best foods are those which give the greatest caloric yield per unit of weight and per unit of cost.

Take the potato, for instance, in weight its nutritive value is poor—900 calories; in cost its nutritive value is high, since it reaches 2,250 calories. It is the opposite in the case of almonds: very nutritive judging by weight, they are far less so when considered by price. As for lean meat, which

has but a very insignificant nutritive value in relation to weight, it shows an energy power even more insignificant in relation to price, namely 205 calories. On the other hand, cereals, legumes, and especially bread, highly energy producing both in weight and in cost, should assuredly form the basis of a diet that is healthy, strength-giving and economical.

All the same, if we replace meat by other food, for the same price, we shall have four or five times more energy with almonds, nuts and oleagenous fruit ; six or seven times more with dried fruit, a milk regime, rice, lentils, legumes, ten times more with potatoes ; and lastly, twenty to thirty times more with bread.

Here is another striking table which indicates, (1) cost of food energy according to the article purchased, (2) cost of food energy with reference to that of bread regarded as the unit.

This table is very instructive, especially in the hard times through which we are passing. The energy supplied by lean meats and fish costs twenty or thirty times more than that afforded by bread. To count upon it for our ration is either illusion or madness. For 50 centimes' worth of bread we purchase 2,700 calories ; for the same value of lean meat or fish we purchase less than 100 calories ! Naturally, limited as we are in bread supply, we have to find substitutes by some means. To seek these in animal flesh, or even in eggs or fresh fruit would be ruinous. Consequently I have put in italics in the preceding table those foods, the energy from which costs scarcely more than that of bread, and upon which —at the beginning of 1918—no restriction was imposed, viz., potatoes, chestnuts, haricots, almonds, nuts, dried figs and fats.

Some remarks, however, are needed as regards the judicious use of these substitutes for bread.

COST OF FOOD ENERGY.

Food	Cost per 1,000 calories				Relation of cost of food and cost of bread giving the same energy			
	1913		1918		1913		1918	
Lean meat ...	2 fr.	65 c.	4 fr.	90 c.	17	6	27	2[1]
Fat meat	1	0	2	20	6	6	12	2
Fowl	2	0	4	0	13	0	22	2
Rabbit	1	80	3	60	12	0	20	0
Lean fish... ...	2	60	5	10	17	3	28	3
Eggs	1	70	3	45	11	3	19	0
Milk	0	40	0	95	2	65	6	35
Corn (wheat) ...	0	12	0	15	0	8	0	83
Rice	0	23	0	85	1	5	4	7
Bread	0	15	0	18	1	0	1	0
Potatoes	0	22	0	45	1	4	2	5
Lentils	0	16	0	80	1	06	4	4
Haricots	0	16	0	60	1	06	3	3
Chestnuts ...	0	30	0	60	2	0	3	3
Fresh grapes ...	1	25	1	85	8	3	10	0
Dried grapes ...	1	12	3	25	7	45	18	0
Dried figs ...	0	44	0	72	2	9	4	0
Almonds	0	60	0	60	4	0	3	3
Butter	0	45	1	37	3	0	7	0
Margarine ...	0	25	0	55	1	6	3	0
Oil	0	30	0	58	2	0	3	2
Chocolate... ...	0	49	0	95	3	2	5	2
Preserves	0	50	1	10	3	3	6	1
Sugar	0	25	0	43	1	6	2	4

[1] This figure 27.2 means that when you obtain your food energy from lean meat, you pay for it twenty-seven times more than if you obtain the same amount of energy from bread. In other words, 27 fr. 20 c. of meat gives you only the amount of energy purchased by one franc's worth of bread. All the figures of the last two columns have the same meaning

(1) Potatoes, being naturally full of water, speedily load the stomach and cloy the appetite. On the other hand, being but moderately nutritive and too rapidly digested, they satisfy stomach and intestines for but a short time and cause hunger to return very quickly, long before meal time. The same remark applies to rice and pastry.

(2) It is therefore wise to add fats, which cost

little and are very nourishing, besides remaining long in the digestive tract.

Fried potatoes lend themselves all the better to this object, seeing that the process of frying involves the evaporation of a large amount of water.

(3) All the same, potatoes and fats give but an inadequate nitrogenous ration. As a result, it will be prudent to use, almost daily, small quantities of haricots or lentils, which are heat-producing and rich in nitrogen, while they are relatively slow of digestion.

(4) Instead of dried vegetables, we may also utilize the nitrogen and fat contained in almonds or nuts, the combustible value of which is remarkable whilst they thoroughly appease hunger.

(5) Finally, special mention should be made of dried figs, which are not costly and yet are of great nutritive value, real complete foods, almost capable in themselves of maintaining life, and very plentiful.

Now let us see how we may realize the official ration of 2,600 calories, which consist of 120 grammes of albuminoids and 300 or 500 grammes of respiratory matter. To simplify things, we will take the pre-war prices.

As I have already said, the flesh-eater, who finds almost the whole of his nitrogen in meat, daily consumes from 600 to 700 grammes of animal flesh which cost him an average of 1 franc 70 centimes. All the same, this ration of meat does not supply him with more than 800 calories. He has still 1,800 calories to find in bread, vegetables, fruit and fats. If he is economical, he will spend another 40 or 45 centimes, making a total of slightly more than 2 francs without counting drinks. It is no exaggeration to admit that these extras increase his personal diet budget about 50 centimes per day.

The semi-flesh-eater spends no more than 60 to

80 centimes on meat, supplying only 340 calories. If he is economical, he will procure the extra 2,350 calories in vegetable food at an expense of 75 centimes, a total of 1 franc 55 centimes. But this sum will necessarily be increased 40 or 50 centimes by drinks, liqueurs or excitants, of which he will not care to deprive himself.

As our vegetarian type, we will take the man who daily consumes on an average half a litre of milk, one egg, one pound of bread, finding the rest of his rations in vegetables, cheese and fruit. We reach a total of 80 centimes,[1] and that is all, for the vegetarian generally refuses alcoholic drinks.

The uncompromising fruitarian takes nothing but fruit. Let us, however, admit a modified fruitarianism which tolerates the moderate use of bread. Then, 250 grammes of oleaginous fruits, 500 grammes of fresh sweet fruits, 250 grammes of bread, will supply, with the necessary nitrogen, energy representing more than 2,600 calories. The cost of this ration gives a total of 1 franc 50 centimes. For non-flesh-eaters, indeed, fruitarianism is a regime *de luxe*. A little less costly than semi-flesh-eating with the addition of drinks, it is yet twice as dear as lacto-vegetable vegetarianism.

It is surely to the *vegetalian* regime that the place of honour is due amongst diets which combine sobriety with economy. Though small in bulk and very moderate in price, it is quite substantial and will ensure a large nitrogen ration and an energy superior to 2,600 calories, with, for instance, 1 pound

[1] Indeed, we have 20 centimes of bread which will give 1,350 calories, half a litre of milk, 15 centimes supplying 380 calories, and 1 egg, 10 centimes giving 70 calories. These three articles giving 1,800 calories, the vegetarian will only have to obtain 800 calories from vegetables and fruits at a cost of 30 centimes. The whole costs 80 centimes.

of bread, 250 grammes of legumes and 500 grammes of potatoes at a cost of 45 centimes per day.

The 250 grammes of legumes, however, must not be accepted as a daily custom, by reason of the purins they introduce into the body.

If you are a semi-flesh-eater and adopt vegetarianism, you will effect a daily economy of 80 centimes including drinks; 1 franc 30 centimes, excluding them.

Under the same conditions, under vegetalism you will economize 1 franc 10 centimes or 1 franc 70 centimes.

The following table gives the annual food expenditure of four persons living economically under physiologically equivalent rations in the different regimes :—

Regime	Annual expenditure 1913	1918
Flesh-eating	910 fr. ...	1,640 fr.
Semi-flesh-eating	710 ,, ...	1,100 ,,
Vegetarian	275 ,, ...	450 ,,
Vegetalian	165 ,, ...	350 ,,

Do you think I am exaggerating and making a special plea for vegetarianism ? I am doing nothing of the kind; indeed, these calculations assume a ration which I know to be excessive and which the vegetarian will reduce by at least 25 per cent. It was not really 275 francs but only 190 francs that a vegetarian expended annually before the war. The *vegetalian* was enabled to reduce his food expenditure to 120 francs per annum.

If you are still incredulous, read carefully the following section which will demonstrate clearly that it is quite possible to obtain nourishing meals and sufficiently varied menus at the prices stated.

IV.

Instances of an Economical, Healthy, Strengthening and Pleasant Diet.

Understand me well: I have not the slightest intention to advocate strict abstinence. You need neither fast nor deprive yourself of anything necessary. But as there are necessarily inequalities of fortune, we will draw up menus at different prices.

A.—Vegetarian Menus practicable in 1904.

I will first go back to the menus of 1904. Then I will give in detail the war menus—taken from a speech I delivered in 1917—on meatless days. Lastly I will deal with the way of adapting these menus to the restricted conditions imposed by the war in the year 1918.

There is one common article of food: bread. Whatever one's social condition, he needs on an average a pound of bread daily. With an expenditure of 20 centimes, this ration gives us all an energy of 1,350 calories. We must consequently obtain about 1,000 calories from the other foods.

Mr. Knight, Secretary of the Manchester Vegetarian Society, undertook to provide these 1,000 calories for the seven members of a family whose total income was less than 100 francs per month. He attained to this result by means of two dishes per meal: (1) a well seasoned soup of legumes, cereals and fresh vegetables; (2) a dish of boiled or baked potatoes eaten with butter. The daily expenditure is reduced to 15 centimes per head, or including bread, 35 centimes.

Here is the meal for seven persons, father, mother and five children. The weight, cost and energy of each food are given.

SOUP.

Haricots ...	500 grammes	...	0 fr. 26 c. ...	1,915 calories
Rice	250 ,,	...	0 ,, 17 ,, ...	882 ,,
Onions	500 ,,	...	0 ,, 05 ,, ...	64 ,,
Herbs and Salt...	— ,,	...	0 ,, 05 ,, ...	— ,,
Water : 4 litres.				

N.B.—To vary, one may use peas, lentils, corn, barley, maize, &c.

SECOND COURSE.

Potatoes ...	4 kilos	...	0 fr. 40 c. ...	3,650 calories
Vegetable butter	66 grammes	...	0 ,, 10 ,, ...	620 ,,
Total expenditure		...	1 fr. 03 c.	Total energy 7,131 calories

The expenditure per head is 15 centimes; each person has 1,020 calories, one half of which is expended at the first meal, the other at the second.

In Bavaria, living is less expensive. Rumford prepared meals for 1,200 persons at an average cost of 6 to 7 centimes per head per day, bread excluded. The soups contained barley, peas, potatoes, bread, salt and a little vinegar; thus there were lacking green or fresh vegetables, the mineral qualities of which are indispensable for physiological equilibrium. Consequently the soup made by Madame van Oberghem is preferable, the proportions being reckoned for four persons and a single meal, according to the following formula:—

Haricots... ...	425 grammes	...	0 fr. 15 c. ...	1,625 calories
Cabbage... ...	400 ,,	...	0 ,, 02 ,, ...	175 ,,
Onions	200 ,,	...	0 ,, 04 ,, ...	25 ,,
Carrots	200 ,,	...	0 ,, 02 ,, ...	110 ,,
Turnips	100 ,,	...	0 ,, 02 ,, ...	62 ,,
Vegetable butter	25 ,,	...	0 ,, 03 ,, ...	210 ,,
Total	...	...	0 fr. 28 c. ...	2,207 calories

Repeated at both meals, this soup gives for 14 centimes 1,107 calories per person, i.e. an energy superior to what we know to be necessary. Do not

forget that to the 1,350 calories of bread must be added the 1,100 calories of soup, giving a total of 2,450 calories.

Doubtless we are a long way from the sumptuous bills of fare partaken of at official banquets, and even from the reader's ordinary meal. But do not forget that we are here dealing with the baffling problem of existence for the masses with wages less than 150 francs per month, though war and post-war conditions have trebled or quadrupled these wages. In the old days, the head of such a family, either flesh-eating or semi-flesh-eating, was struggling with an almost impossible condition of things. But suppose that he had been a vegetarian, he would have supplied his family with a proper and substantial diet, and saved sufficient for clothing and rent.

Now let us suppose—excluding bread as before—that we have to dispose of 25 centimes per person. Then we can easily provide a three-service meal: soup, savoury, and dessert or side-dish. Here is a menu for a family dinner for six persons, at a cost of 25 centimes per head.

(1) Scotch Broth.

Barley	31 grammes ...	0 fr. 03 c. ...	110 calories
Oat gruel... ...	31 ,, ...	0 03 ...	105 ,,
Carrots	500 ,, ...	0 05 ...	270 ,,
Turnips	250 ,, ...	0 05 ...	155 ,,

(2) Haricot Stew.

Haricots	700 grammes ...	0 fr. 35 c. ...	2,660 calories
Potatoes	2 kilos ...	0 20 ...	1,816 ,,
Butter	30 grammes ...	0 10 ...	250 ,,
Parsley	— ...	0 10 ...	—

(3) Pudding.

Ground wheat ...	250 grammes ...	0 fr. 10 c. ...	892 calories
Bread crumbs ...	250 ,, ...	0 08 ...	550 ,,
Currants	100 ,, ...	0 20 ...	300 ,,
Sugar	125 ,, ...	0 13 ...	512 ,,
Grated carrots ...	500 ,, ...	0 05 ...	270 ,,
	Total...	1 fr. 47 c. ...	7,890 calories

V.

Diet Reform from the Social Point of View.

I am well aware that there are many objections to diet reform. I have no desire to deal with those formulated in the name of routine and prejudice, still less with those inspired by a somewhat vulgar sensuality. Everyone knows that the pleasures of the table run away with both money and health, and it is more than likely that my readers are solicitous about the one or the other, if not about both.

The objections based on history, physiology and therapeutics I have answered in previous pages, so there is no need to return to them now. All the same, there are objections of a social order which are deserving of consideration. The greater part, it must be confessed, are so imaginary or childish that I will not dwell upon them.

"Diet reform," we are told, "will by no means bring the workman the material relief expected, for the greater consumption of vegetables will considerably increase the market price of vegetable foods." This objection is quite valueless, indeed, we shall shortly see that the suppression of meat, i.e., of a portion of the cattle, would result naturally in a rapid increase of the fecundity of the soil, from the food point of view.

Suffice it to note, however, that the meat ration, which the semi-meat-eater values so highly, supples him with only 40 grammes of albumen, and brings to his reserve of energy only 300 calories out of the 2,600 he ought to absorb. If he really consumes a total daily ration of 2,600 calories, let him simply suppress his 50 centimes of meat! . . . There will still remain 80 grammes of albumen to make up for his expenditure and 2,300 calories to maintain

his strength, and these amounts are quite sufficient to ensure the physiological balance of an adult man who works moderately hard. All the same, if one absolutely persisted in losing nothing of one's physiological ration, a potato as large as one's fist would replace the 200 or 300 calories given up with the meat. Such is the whole of the reform we propose; surely it is unlikely to make any impression on the market price of vegetables and cereals! . . .

"Still," says another, "your reform would produce a veritable social upheaval by ruining cattle breeders, butchers and pork butchers and by throwing out of work the many people they employ."

One of our most erudite French vegetarians gives the following witty reply to this objection. "Was there any hesitation in replacing the stage-coaches by railway trains on the plea that the innovation would be objected to by coachmen, or in substituting electricity for gas, lest those who laid down gas pipes might be compelled to learn to fit up electric wires? . . . The one thing of importance to note is that the general total of work is not diminished. . . . If we were to listen to such objections we should have to abandon all idea of progress in any direction. Are not the railway workers far more numerous than those employed under the old stage coaches? Cattle breeders will easily find plenty of room among the ranks of the gardeners. . . . Even if it were otherwise, the question of public health would take precedence of all else. When we consider the terrible ravages of alcoholism we may well regard as necessary the reduction in the number of public-houses without troubling about the landlords. . . ."

We will also refrain from replying to those who ask what would become of the cattle if vegetarianism

won the victory. Do people take less interest in automobilism because they are concerned as to what will become of the horses?

As a matter of fact, over-breeding assuredly introduces a heavy responsibility into social problems. Requiring fewer hands than agriculture, it increases the exodus from country to town and city, thus intensifying competition, depreciating wages, creating scarcity of work and daily adding to the numbers of the wretched and starving city populations.

On the other hand, "the increased consumption of vegetables," adds the authority just quoted, "would send back many unoccupied people to the fields where they would find assured means of existence under infinitely superior hygienic conditions."

Will not these important conclusions suffice to reassure those who are concerned as to how vegetarianism would affect the flesh-eating industries? . . . Do they not also interest the economist, dismayed at the growth of our great working city populations? Above all, do they not give a decisive reply to those who claim that vegetarianism would bring about a rapid rise in the market price of vegetables? Supposing the suppression of meat were to effect a notable increase in their consumption (which, as we have seen, is by no means necessary) the substitution for cattle breeding of an equivalent cultivation of vegetables would speedily effect the right balance between consumption and production.

Nay, the objection turns against our opponents. In ending this chapter I propose to prove that the substitution of agriculture for cattle breeding would so increase the energy yield of the soil, that not only should we find the cost of vegetable foods diminish, but we should be able, without causing

any social crisis, to increase, considerably, on the same extent of ground, the number of mouths that could be fed. I will explain.

Hunter's observations and calculations show that one hectare of grazing land gives annually in meat an energy of 785,000 calories, including the energy supplied by the fat, and 160,000 calories only from the meat alone. Grandeau's statistics also show that 1,200 kilogrammes of wheat can annually be grown on each hectare, i.e., an energy of 4,450,000 calories. Hence this first conclusion:—

The food energy yield of cultivated land is six times greater in cereals than in fat meat, and eighteen times greater than in lean meat.

From this we may easily calculate that 3 acres of land in English measures produce in cattle sufficient to feed for a year a man who eats fat, and that it supplies only a third of this nourishment to one who abjures fat.

The same surface under corn cultivation will feed six adults for a whole year.

We must now take into account the practical and technical side of the question, and consider the conditions of the distribution or succession of crops. The same land is incapable of supplying its harvest of corn year after year. This is a necessity imposed by the needs of the soil itself. We will therefore accept the principle of crop distribution by thirds and see what we can make of these 3 acres which, as we have seen, will supply food in corn for six adults. We divide the area available into three equal parts, one for corn, another for vegetables and potatoes, and the third for lucern or some other leguminous plant suitable for fodder. An annual change will ensure the return of the same crop for each food every three years.

A calculation of the yield of crop-distributed

soil in accordance with this principle is easy to make.

The first part should give 470 kilogrammes of corn, i.e., 750 kilogrammes of bread per annum. As there are six persons to feed, each will receive daily 420 grammes of bread.

The second part will ensure a superabundant ration of vegetables. In fact, less than one half the area will supply the annual consumption of six adults, i.e., almost 280 grammes per head, per day.

Lastly, as a hectare of lucern feeds a good milch cow which will give 16 litres of milk daily, our third plot of land represents a yield of almost six and a half litres of milk, i.e., slightly more than one litre per person per day.

To recapitulate:—

420 grammes of bread give 1,100 calories and 37 grammes of nitrogenous matter. One litre of milk supplies 750 calories and 36 grammes of nitrogenous matter. Lastly, 600 grammes of mixed vegetables give a minimum of 50 grammes of albumen and an energy of 950 calories[1].

Thus our three acres give a most plentiful stock of food for six adults. Still, as no one lives exclusively on fat or lean meat, it would be absurd to conclude that land, tilled for vegetarianism, feeds six times more vegetarians then semi-flesh-eaters.

[1] I take for granted that the yield of the vegetable-planted soil is, in twentieths:—

One	twentieth of	onions and leeks
One	„	turnips
Two	„	cabbages
Two	„	carrots
Six	„	legumes
Eight	„	potatoes

A proportional calculation, based on the chemical composition of each of these vegetables, will give, per kilogramme of the mixture, 100 grammes of albumen and 1,500 calories.

Still, the semi-flesh eater, with 270 grammes of lean meat consumed, requires for cattle nearly one half the ground available, and solely for his ration of nitrogen takes the place of two vegetarians. It must therefore be admitted that semi-flesh-eating in a country requires two or three times as much space as vegetarianism. Forty years ago Dr. Anna Kingsford, in her eloquent thesis,[1] was even more optimistic, maintaining before the *Faculté* that *vegetarianism, even including milk, cheese and butter, would enable a semi-flesh-eating nation to feed three or four times the number of its inhabitants.*

Are not the social consequences of this conclusion eminently suggestive, especially in times when the yield of the soil in food is becoming a matter of life or death, not for France alone, but also for the whole of mankind ? . . . .

[1] *The Perfect Way in Diet.*

CHAPTER V.

THE FEEDING OF THE HUMAN MOTOR.

I.

Animal Thermodynamics—Work and Sport.

In these days of the motor car and of the triumph of steam and electricity, when the brute forces of Nature seem to be all yoked in service to the will of man, it may seem childish, almost ridiculous, to introduce an investigation into the energy of living organisms. A pure anachronism, I shall be told. On hearing mention of the human motor an engineer will smile, for he will think of those giants of 20,000 h.p. by which our modern floating cities are propelled across the Atlantic. The speed and endurance of our best runners may prove a matter for jesting now that the world is streaked with these roaring engines on road or rail, whose fantastic course carries us in a few hours from one end of the land to the other. True, he may say, you walk your seven kilometres an hour, but our motor cars easily do one hundred and twenty! . . . . And lastly, of what importance are the 300,000 kilogrammetres of your strongest workman, when I need only press a lever in order to produce a result a thousand times greater! . . . .

Assuredly, this extraordinary development of industrial force, the outcome of the inexhaustible fertility of the human mind, amazes us quite as

much as it does modern mechanics; we have no intention whatsoever to decry it. We shall not even discuss the question of the economic danger incurred by substituting mechanical force for human energy. But just because there is nowadays too great a tendency to disregard the principles and utillity of animal mechanics, it may be of use to state that the human body is also a machine, a real motor admirably suited and adapted for work. I wish to show that this motor, so speedily impaired by illness when it is neglected, gives a wonderful mechanical yield if normally developed. Finally it is my intention to find out what is the diet regime, i.e., the fuel required by the organism to produce the driving power and the full manifestation of its powerful activity.

II.

The Living Motor—Source of Energy—Mechanical Output.

Every motor is a transformer of energy. The motor does not create force; it borrows it from without and then produces it in a form that can be utilized mechanically. Thus the fire engine, fed with coal, sets free the combustible energy therein to produce the elastic force of gas or steam and then the backward and forward motion of a work-generating piston. The water machine, the turbine, when subjected to the shock or pressure of a down-flow of water, concentrates the living brute force which strikes it in such a way as to supply, by means of its regular and rapid rotation, an inexhaustible source of industrial power. The electrical motor utilizes the magnetic action of the current-traversed coils to give life to the axis that produces mechanical energy.

However we may multiply instances, we shall always find *transformation*; never do we look upon the motor as a *creator* of energy. Though frequently inaccessible to ordinary sense investigation, energy is nevertheless present where we do not see it, ready to manifest itself whenever some favourable circumstance brings it within our field of observation, and to disappear once again in the long series of transformations which it may undergo. For instance, confronted with the visible phenomenon of electric light we must seek for the energy of the current producing it, and that of the heat following it.

In short, energy is always conserved, and this principle of conservation governs and controls every investigation of nature.

Nothing can escape this law, either in the world of living beings or in that of inert bodies. "Life," says Laulanié, "does not create energy." Neither does life destroy it, and when the animal develops his activity, he remains inevitably subject to the universal laws of conservation and transformation of energy, i.e., to the very rules which control the mechanism of our industrial motors. I will explain:—

Let us first study the animal at rest.

This rest is but apparent, for the organism is the seat of an inner process of nutrition, of an uninterrupted succession of phenomena necessary to life. The strength of the cardiac impulsion, the intensity of lung oxygenation, the mechanical effort of the digestive organs, the secretions of the liver, the emission of the nerve influxes of medulla and brain; are not all these physiological processes the manifest expression of both the need and the expenditure of energy?

Consequently, even though the body does no visible

work whatsoever, it is still a consumer of energy. This it obtains from without, places it for some time at the service of its inner mechanism, and throws it out fresh into the surrounding medium, without having either lost or destroyed the slightest trace of it.

How is the complete cycle of energy brought about through this living organism? This is easy to understand.

Everyone knows that the animal obtains its strength from those foods which represent the reserve, the *potential* chemical energy.[1] It digests and absorbs the food, and, releasing the energy contained therein, utilizes it for the normal maintenance of life. From being chemical and alimentary, energy has in a way become physiological and vital. After utilizing it, however, for the building up of tissues and organs, the animal transforms it into heat and throws it off. Opened by the absorption of food energy, the energetic cycle of the animal at rest is closed by the release of heat. In virtue of the principle of conservation, this heat represents exactly the entire energy of the food consumed and utilized in the process of nutrition. It therefore indicates both the potential energy of the maintenance food ration and the vital intensity of the organism. Thus we express in calories or units of heat the value of this maintenance ration; for instance, we say that the adult man at rest who consumes 120 grammes of albumen, 50 grammes of fat, and 400 grammes of hydrates of carbon, disposes of a daily energy of 2,600 calories.[2]

[1] A potential is a force ready to be released.

[2] To calculate this heat, we must remember that 1 gramme of these three substances, in combustion in the body, releases:

Albumen	4·1 calories
Hydrates of carbon	4·1 ,,
Fats	9·0 ,,

Still, with this maintenance ration which simply assures its inner physiological mechanism, the organism cannot yet find the energy necessary for outer movement.

Let us now suppose that it is working; or, in other terms, let us see how energy is used in an animal *motor*.

When at work, apart from the maintenance physiological ration, the animal must absorb a work ration. In this case, the food consumed by the animal motor is no longer entirely transformed into heat, seeing that a part of it produces work. All the same, we still express in calories the value of a work ration, as though it had to undergo complete transformation into heat; we say, for instance, that the workman who consumes an extra ration of 60 grammes of albumen, 30 grammes of fat, and 180 grammes of hydrates of carbon, is a motor that employs, in the production of its work, an energy of 1,350 calories.

Let us proceed further into the analysis of our motor.

First, we must define the numerical relation between units of heat and units of work.

As we know, the unit of heat is the calorie, that of work the kilogrammetre, i.e., the work produced by raising one kilogramme to the height of one metre.

The investigations of Rumford, Mayer, Tyndall, &c., show that an apparent destruction of work or of live force produces a fixed quantity of heat; and, vice versa, that the manifestation of a fixed effort corresponds with the amount of heat that has disappeared. In other words, there exists a relation of equivalence between heat and work. The work reckoned in kilogrammetres which corresponds to one calorie has been named the mechanical equivalent of heat.

Various methods, including those of Joule and Mayer, have given for mechanical equivalent the average figure 425. This means that the work corresponding to 1 calorie is equivalent to 425 kilogrammetres, or again, that the heat which corresponds to 1 kilogrammetre is equivalent to 1/425 of a calorie.

An example will explain this equivalent. We will place in a calorimeter a small steam engine, with the furnace lit, though the machinery is not working, and register the heat it produces per hour. Now we set the engine going, so as to make it do the work apart from the calorimeter. Although, in this novel experiment the amount of coal burnt is exactly the same, there will be less heat produced, the deficit being at the rate of 1 calorie per work of 425 kilogrammetres produced by the engine.

Thus, as we know the figure of the calories transformed into work, all we need do is to multiply this figure by 425 to have in kilogrammetres the work produced.

A motor, however, is far from being able to transform into effective work the whole of the calorie energy at its disposal. It is well known that in the best fire motors, out of 12 calories burnt only one is transformed into work. This is expressed by saying that the mechanical output of the motor is 1/12.

In the best gas engines, the output is still no more than 1/10·8.

What then is the output of living motors ? Let us try to find the answer to this question.

We have seen that when the animal works, to its "repose" ration must be added a "work" ration defined by a certain number of calories : for instance, 1,800 calories.

A certain fraction of this energy is used to develop internally the contractile capacity of the muscle, the

other fraction corresponds to the external work produced by this contractile power.

The best physiological investigations tend to prove that, of the total energy utilized by the muscle in activity, one-third is transformed into external mechanical energy, whereas two-thirds passes first into internal work and afterwards reappears as heat.

The fraction $\frac{1}{3}$, however, does not yet represent the effective and practical output of the animal motor. Indeed, there are many accessory muscular movements for the play of the various parts of the motor and the mechanical conditions of its equilibrium. The fraction $\frac{1}{3}$ is but a theoretical and ideal output which we shall approach in certain special exercises where the accessory movements are reduced to a minimum, and mostly by such training as facilitates movements whilst increasing skill.

Consequently, it is prudent to lower the practical output to one-fifth, as the authorities do. The observations of Grandeau, Muntz and Wolff on the rationing of draught horses indicate practical outputs as between 18 per cent. and 22 per cent.

On the other hand, the interesting investigations of A. Gautier on the robust workers in the wine-stores of the South of France, confirm and complete these results. With a ration of 1,800 calories, which correspond to 750,000 kilogrammetres, the total work is only 250,000 kilogrammes. The output is thus one-third. But of these 250,000 kilogrammes, 150,000 are effective, for they are strictly measured by filling with a pump a tun containing 150 hectolitres, 10 metres in height. The difference of 100,000 kilogrammes represents the accessory work that is expended in overcoming the friction of the pump, and producing the lowering and raising

of the trunk and limbs, the breathing movements, &c. The effective work is no more than 150/750 or one-fifth.

The proof is complete, and is summed up in the following table :—

Output in heat : 2/3 or 66·7 per cent.	Effective work, 20·0 per cent.
Output in work : 1/3 or 33·3 ,,	Accessory work, 13·3 ,,

Let us again note regarding the output of living motors :—

(1) The exercise and skill which lessen the number of awkward movements increase effective output ;

(2) Certain works, by their very nature, bring about a diminution of accessory work and give an output of over one-fifth ;

(3) In sport, where no one troubles about economic output, the mechanical output which expresses the total force of the motor (including the work performed by heart and thorax) is practically equal to one-third.

III.

The Phenomena of Combustion in Animal Thermodynamics.

The animal motor then transforms a portion of the food energy into work. We shall now see where and how.

The most commonplace observation shows us what *a thirst for air* is developed by exercise. This thirst is the expression of an imperative need of oxygen on the part of the animal motor at work. Indeed, ever since the famous investigations of Lavoisier on respiration and combustion, it is generally well known that the living being consumes oxygen and throws off carbonic acid. In

a way, it burns up its food, as the stove burns up coal, and so sets free the energy needed to develop strength and activity. This discovery of Lavoisier has been confirmed by all the authorities. These latter have entered into details, showing that heat, as we have just seen, appears only at the end, and, as it were, in order to complete the internal vital work, and that it does not even appear except incidentally when the organism, functioning as a motor, is doing some external work.

In any case, the food energy is released by the action of the oxygen breathed in, and we may conclude that combustion releases, transforms and gives up to the organism the potential energy of the food absorbed.

Most certainly combustion increases with the amount of work produced. Lavoisier had noticed that, during moderate movement, man absorbs three times as much oxygen as when he is at rest. Smith demonstrated that slow walking requires only twice as much air as is required by one who is resting in bed, whereas rapid walking and running require respectively four and seven times as much.

In a word, the consumption of oxygen, proportionate to the amount of combustion, gauges both the intensity of life and the calorific power of the body at rest, also the combined calorific and motor power of the same body at work.[1]

We now have to determine the seat of this combustion. As a matter of fact, the food potential

[1] It is therefore evident that the physiological activity and mechanical vigour of an organism partially depend on its respiratory power. The development of this respiratory power is thus an essential condition of maximum output in the animal motor. In a word, the most muscular man is incapable of any forced or prolonged exercise if he neglects the training and development of the breath.

and the respiratory oxygen, spread throughout the body, are at the service of all the organs, the one for giving energy, the other for releasing it. In a word, combustion takes place everywhere, but it is the muscles of the animal motor, which, when a movement is made, must become the essential foci of the energetic transformation which produces their work. This is proved by experience. Claude Bernard demonstrated the existence of a combustion, a considerable muscular respiration, which increases with the amount of work performed by the muscle. But it was mainly Chauveau who clearly proved the nature and importance of this phenomenon. When the organ is working vigorously, not only is circulation rapidly increased, but the oxygen consumed, the carbonic acid thrown off, may, in this particular focus, become twenty or thirty times greater than when the organ is at rest.

I will conclude this introduction to nutritive and mechanical physiology (necessary to the reader before entering upon the thermodynamic problem of food energetics) with the following statements :—

(1) There are two diet rations : that of upkeep and that of work ; from the former the organism obtains directly the energy necessary for its nourishment in rest ; from the latter, it obtains the energy of the mechanical muscular effort ; heat appears only at the end of the cycle of energy.

(2) The organism in motion, which produces mechanical force at the expense of the food potential, is a genuine motor.

(3) The food potential is a reserve of energy ; its liberation is effected by the oxygen breathed in, by the chemical process of combustion, and this respiratory combustion, especially active in the muscle at work, grows in proportion to the intensity of this work.

(4) The food potential, consumed by the muscles of the motor, absorbs oxygen and releases carbonic acid; it is thus eminently combustible matter.

In a word, there does exist a combustible suited to the work of the animal machine. What is the nature of this vital combustible? The next section will tell us.

IV.

Investigation into Muscular Combustible—Nutrition of the Body at Rest and at Work.

As we have already said, every food substance belongs to one of the three following chemical families: nitrogens or albuminoids, fats, hydrates of carbon. (For the moment, we will say nothing of mineral salts which are not energy producers.) After digestion, all hydrates of carbon are transformed into glucose sugar, an assimilable sugar particularly abundant in fruits. Finally the food potential offered to the animal motor consists solely of albumen, fat and glucose.

Are these three substances equally useful, or is one of them specially intended to serve as vital combustible? It is easy to find out.

Popular prejudice would affirm that to albumen belongs the privilege of supplying force. Do not people continually take a large meat ration in order to obtain energy? Doubtless you have frequently heard it affirmed that if you would have muscle you must eat muscle. This is all the more ridiculous when we consider that the muscle we eat (meat) has first to be totally decomposed before entering the blood for the purpose of restoring subsequently what the body has lost in nitrogen. This prejudice has perverted scientific teaching ever since Liebig,

the famous German chemist, affirmed that "the muscles obtain their energy from the nitrogenous substances of which they are composed." Indeed, it is well known that Liebig separated food into two categories : plastic foods, producers of muscle and strength; and respiratory foods, producers of heat. The former contained the various albumens, principally the albumen of meat; the latter were represented by the sugars, starches and fats.

This gratuitous hypothesis, opposed to the very principle of vital mechanism, has been rejected by modern physiology. "It is easy," said Laulanié, "to justify this systematization of foods which is absolutely opposed to the fundamental principles of biological energetics. A conception which refers heat and force to separate origins cannot be upheld nowadays."

Let us leave these theories and appeal to direct experience. This will show us that, instead of finding energy in albumen and meat, the animal motor, whilst working, consumes no nitrogenous matter at all.

The experimental problem is clear : if, in exercise, the living machine employs nitrogenous matter, we ought to find a considerable increase of nitrogen in the various excreta, especially in the urea [1] thrown off by the organism. Now, experience proves that these nitrogenous excreta are not increased in the slightest by muscular work; the body therefore does not obtain its strength from albumen.

Here are facts which will leave you in no doubt whatsoever.

I will first quote the well-known scientific excursion of Fick and Wislicenius. These two physiologists in 1865 together undertook a methodical

[1] Urea is the main substance through which nitrogenous excreta are eliminated from the body; it is found in urine.

ascent of the Faulhorn to the height of 3,000 metres. They examined the nitrogen in their urine before, during and after the excursion. The proportion of nitrogen remained invariable.[1]

A little later, experimenting on the dog and the horse, Voit[2] on the one hand and Wolff[3] on the other reached the same result. We thus come to the following conclusion :—

Albumen, essentially intended for renewing living matter, serves in no way to maintain the energy of the animal motor. In other words : the expenditure of albumen is not increased by muscular work.

I now maintain with Chauveau—and prove my assertion by the light of the clearest and most irrefutable physiological teaching—that glucose sugar is the only potential, the sole combustible used by the animal motor.[4]

Is not this proved by the facts here advanced ? Some of these facts show that albumen is not the immediate source of muscular energy ; others teach us that the potential consumed by the muscle is a true combustible. Now, the combustion of fats does not explain walking and breathing in the working animal, whereas the combustion of glucose sugar accounts for these exactly.

Thus it is really glucose which alone represents the muscular combustible. This demonstration

[1] In reality the nitrogen eliminated during work is one-thirtieth more than that eliminated during rest. This slight increase however does not explain the energy of the 200,000 kilogrammetres worked out by the experts.

[2] Quoted by Richet, *Physiologie des muscles et des nerfs*, Baillière, 1882.

[3] Quoted by Laulanié, *Energétique musculaire*, Encyclopédie Léauté.

[4] Chauveau and Kaufmann. *Le travail musculaire et l'énergie qu'il représente*, Asselin, 1819.

being indirect may perhaps seem inadequate ; we will therefore consider a direct experiment.

In 1856, Claude Bernard[1] made one of the most brilliant discoveries in experimental physiology, showing that the liver is incessantly occupied in producing glucose sugar. Chauveau gave this discovery its full significance by proving that the sugar elaborated by the liver is consumed in every part of the body by the living tissues. Then, specially dealing with the muscle, Chauveau carried through the well-known experiment which enabled him to affirm that "the amount of sugar really expended by the muscle, first at rest and then in activity, is in direct ratio to the intensity of the intramuscular combustions and is sufficient to account for these combustions."[2]

Chauveau's experiment was made on the masseter muscle of the horse. During work, the oxygen and carbonic acid of the muscle are increased fourfold ; at the same time, the consumption of glucose sugar by the muscle is also increased fourfold ; i.e., the expenditure of sugar is in proportion to the work produced.

The demonstration is a decisive one and we may affirm with Chauveau that glucose is the immediate food supply of combustions concerned with the production of muscular force.

Thus, hydrates of carbon, the digestive transformations of which invariably culminate in glucose sugar, represent the immediate or proximate combustible of the animal motor. These are the foods that supply work and strength ; for this reason they should form the essential basis of all work rations.

[1] Claude Bernard. *Leçons sur le diabète et la glycogenèse animale* (Collège de France, Baillière, 1877).

[2] Chauveau, *loc. cit.*

This is proved by studying nutritive relations when we pass from rest to work.

Nutritive relation may be defined as the relation between the nitrogenous and the non-nitrogenous substances of which a ration is composed. Authorities have given the nutritive relation as one-fourth. Without for the moment disputing the correctness of this figure, we may remark, along with the same classical authorities, how the relation lowers when passing from the rest regime to the work regime.

As regards the horses of the *Compagnie des Petites-Voitures*, Grandeau and Leclerc[1] find the relation to be one-seventh. The same figure is given by Muntz[2] for the *Compagnie Générale des Omnibus Parisiens*, and by Wolff[3] in the ration he suggests for harness and saddle horses. Finally the value of the nutritive relation goes down to one-eighth in the regime supplied to their horses by the Omnibus Company of Berlin.

These figures are still too high. At the beginning of this work we demonstrated, along with Lapicque, that a nitrogenous ration of 50 to 60 grammes is always sufficient for a man. At rest he must add about 400 grammes of non-nitrogenous substances. A good workman requires from 500 to 600 grammes. One engaged in intense sport needs from 600 to 700 grammes of hydrates of carbon.[4] The total, as regards the nutritive relation, i.e., the relation between the nitrogenous part and the non-nitrogenous part of the whole ration, gives us the following figures:—

[1] Grandeau et Leclerc. *Alimentation du cheval de trait*, Paris, 1882.

[2] Muntz quoted by Laulanié, *loc. cit.*

[3] Wolff. *Alimentation des animaux domestiques*, Paris, 1888.

[4] J. Lefèvre. *Société de Biologie*, 1902.

Rest ...	...	one-seventh.
Average work	...	one-tenth.
Intense work	...	one-twelfth.

We thus see that at rest there is needed seven times more non-nitrogenous food than nitrogenous food, and at work even ten or twelve times as much.

We now understand the well-known saying of Dr. Bouchard : " It is by no means my wish that muscular work should be carried on with meat. . . . The doctors are guilty of this great error. It is rather for them to make known the truth and show how great is the abuse of flesh-eating and what harm results therefrom, both to the public wealth and to the public health ! . . ."

V.

Work performed by the Organism in producing Sugar; Hepatic and Muscular Glycogeny.

Glucose sugar is so indispensable to the animal motor that the organism possesses a special function for producing it and ensuring its regular distribution to each muscle.

This sugar-producing function, as has been said, was discovered by Claude Bernard in his investigations into hepatic glycogeny. The great physiologist first proved the constant production of sugar by the liver, showing that this sugar comes from a reserve of the liver, identical with vegetable starch, which he named *glycogen*. This production of sugar at the expense of hepatic glycogen is so well distributed according to the needs of the various organs, that there never remains more than a tiny trace of it in the blood. The liver also stores up, still in the state of glycogen, the intestinal sugar supplied by the

digestion, so as to leave in the blood, even after meals, only the normal proportion of glucose, an average of 1 to 5 per 1,000. Finally, not only does the liver regulate the output of sugar, it also ensures its own supply by transforming the products of digestion, as well as the albumen itself, into glycogen. Such, in short, is the important discovery of Claude Bernard.

This discovery tells us that the liver, all the same, produces glycogen and sugar,[1] and that, if forced to do so, it makes sugar out of meat, so true is it that the body imperiously demands the glucose we so often refuse it, although it is the one essential element in its strength and in its motor energy.

To this production of hepatic sugar there is an indispensable complement, a function calculated to ensure the regular supply of the muscular system, for the motor must store itself with glycogen during the periods of rest if it is to find in its own mass the energy capable of satisfying the initial needs of its activity. This muscular glycogen, however, would speedily become exhausted in continuous work. Besides, it represents scarcely more than one-twelfth of the glycogen stored away by the liver. Consequently, when exercise is somewhat prolonged, it is the liver itself that undertakes, by means of the circulation of the blood, to supply the active muscles with the precious combustible they need.

Thus comes about one important service performed by glycogeny, which obtains its supplies from the central hepatic focus and spreads along the many circular tracts to the numerous peripheral

[1] Glycogen and glucose are transformed into each other according to circumstances. Glycogen is the form of the organism's state of repose and of the deposit of carbon hydrates; sugar is the form of its activity. (Dastre.)

muscular foci. This service represents one of the main functions of the organism, since it ensures the production, the reserve, and the perfect distribution of the combustible in the animal motor. Chauveau has shown the solidarity of all the parts of this great glycogenic apparatus, proving by direct experiment that muscular functioning requires from the liver a superactivity of the glycogenic function for renewing the potential expended in work. This solidarity of the central focus with the peripheral foci is such that the organs which consume sugar are never famished. Thus we may affirm with Chauveau that the liver is strictly and exactly the indirect collaborator with the muscles.[1]

In addition, we have an interesting experiment made by Kulz abundantly proving this collaboration.

In a dog, which for several days had been kept in a state of inanition, glycogen is still found in the liver; but, food failing, and the animal being exhausted, this glycogen cannot be restored. Under these conditions, if the dog is made to work, and the liver is examined immediately afterwards, it is seen that the whole of the glycogen has disappeared. Could the hepatic origin of muscular strength and food be proved more clearly or decisively? . . .

[1] We may well imagine that the capacity for prolonged exercise requires an active liver. And care must be taken to prevent it from being overtaxed with glycogenic extraction during the exercise. This overtaxing may be avoided by eating substances containing sugar and refusing albumen or fat.

VI.

Energy Relations in Food Species: Problem of Substitutions. Theory of Isodynamic Equivalents and that of Isoglycosic Equivalents. Caloric and Mechanical Outputs of Food Species.

Our analysis is becoming more precise. We are acquainted with the potential destined for the mechanical work of the organism, and we know that there exists a special function for ensuring the uninterrupted production of this precious combustible.

But we must not forget, either, the variety of food species offered by Nature to man and animals. Manifestly a ration neither can nor should consist wholly of sugar. The requirements of nitrogenous equilibrium, the resources of each country, the need of variety in menus, the diversity of economic conditions, and, throughout the animal kingdom, the various instincts of the many species which ensure the balance of the living world: all these considerations along with others compel us to extend our horizon when we consider the practical problem of food substitutes.

When substitutes are mentioned, however, remember that glucose sugar remains the only muscular combustible. Do not imagine that the muscle sometimes accepts the direct combustion of fats or albumens. On the contrary we know that the object of hepatic glycogeny is to ensure, throughout the variations of intestinal food, the uniformity and permanence of muscular food *which cannot vary.*

While muscular food is fixed, however, it is not so with intestinal food which, once more, is variable. The different food species are thus called

in to *become substitutes* for one another. Now, these substitutions are permissible only if they respect the energy balance of the organism. How then can this come about? We shall now see.

As we have already discovered, each food substance releases an energy equivalent to its combustion heat. Thus, two weights of foods are isodynamic, i.e., of the same energy, if they release the same amount of heat. These isodynamic weights, according to Rubner, are physiologically equivalent and may be replaced, as regards energy, in the food ration.

The following are the isodynamic weights corresponding to 100 grammes of fat:—

Fat	100
Starch	229
Cane sugar	235
Albumen	227
Glucose...	250[1]

To produce as much energy, then, as 100 grammes of fat, either 220 grammes of starch or 235 of sugar, or again 227 of albumen or 250 of glucose are needed. Such is the teaching of Rubner. This theory, however, is much disputed; certain physiologists regard it as dogmatic, others as most erroneous.

As a matter of fact, there is exaggeration on both sides. We will try to remove the ambiguity.

If we are dealing with the total energy—mechani-

[1] These equivalents are based on the following figures, defined by Rubner and accepted by Landois for the combustion of 1 gramme of matter in the organism:

Fat	9·34 calories
Albumen	4·20 ,,
Starch	4·20 ,,
Cane sugar	3·96 ,,
Glucose	3·75 ,,

cal, caloric or other—produced through the tissues of the body, then Rubner's equivalents are correct; it is perfectly true that 100 of fat produce throughout the whole of the organism an energy equal to that of 256 of starch. This is an experimental fact. I may even add that it is these figures and isodynamic equivalents that have to be utilized in calculating rations of rest or for food substitutions in cold-resisting regimes.[1]

When, however, we deal with movement and work, with the energy of the acting muscular system and the capacity of each food species to supply the combustible required by the animal motor, then the use of Rubner's equivalents becomes inexact and we are no longer able to say that 100 grammes of fat supply the same mechanical energy as 250 grammes of glucose.

Indeed, fat will become a combustible for the muscle only after being transformed into glucose, and this preliminary transformation will expend in heat a fraction of energy lost for muscular activity.[2] Consequently the value of a food from the mechanical point of view, in an animal of perfect balance of weight, is proportional not to its initial caloric energy but simply to its output of glucose. In other

[1] It is well known and we shall again demonstrate, that animal heat largely takes place in the various chemical operations that have their seat in liver, glands, brain, &c. . . . where the glucose potential is not necessary and remains, perhaps, inutilizable. Still, we must remember that, even at rest, the muscular system admittedly produces 40 per cent. of the total heat of the body.

[2] This transformation takes place most certainly in the liver; but, in any case, Berthelot's thermochemical laws tell us that it must inevitably cause the release of 3·3 calories per gramme of fat transformed into glucose. The same laws state that the gramme of food albumen, to be transformed into 0·8 gramme of glucose, gives the organism a heat of 1·2 calorie.

words, as regards the problem of food substitutions, in the animal motor, when moving, the quantities of matters which may mutually be replaced are those which supply the same weight of glucose: they are isoglucosic. . . .

It is interesting to compare these isoglucosic equivalents—still called Chauveau's equivalents—with those of Rubner, in the study of heat and force rations. The following is what this table shows for 100 grammes of fat.

Foods	Rubner's equivalents	Chauveau's equivalents
Fat	100	100
Starch	229	146
Cane sugar	235	153
Albumen	227	201
Glucose	250	161

We see how much these equivalents differ. For instance, whilst taking into account digestive tolerances, we note that the fat which is so useful in a cold-resistance regime loses a large proportion of its advantages in a work regime.

The experiments whereby Chauveau justified isoglucosic equivalences, in work, are worthy of mention. The work which a dog could do without changing weight, on a daily ration of 100 grammes of lard added to its normal maintenance ration, was determined beforehand. Then it was made to do the same work, substituting for the fat its isodynamic equivalent of sugar, viz., 235 grammes. At the end of this second period of work, the animal had increased in weight, proving that the isodynamic substitution of sugar is exaggerated. But if, on doing the work for the third time, we make the simple isoglucosic substitution of 153 grammes of sugar, the weight of the animal remains stationary. Using the various food substances, the

result obtained by Chauveau was the same: substitution ought always to be effected according to the isoglucosic weight of Chauveau, never in accordance with the coefficient of Rubner.

The result may be summed up in the three following laws :—

(1) The various food species may be substituted for one another by energetic equivalence, according to determined weights.

(2) At rest, when the total expenditure of energy is essentially thermogenetic, it is the caloric equivalents of Rubner (isodynamic weights) which represent, from the energy point of view, the proportional numbers of the food substitutions.

(3) In work, when the motor energy is entirely obtained from glucose, it is the equivalents of Chauveau (isoglucosic weights) which express, from the mechanical point of view, the proportional numbers of the food substitutions.

Consequently, if you set up "repose" ration for the thermogenesis,[1] foods must be taken that have the caloric coefficients and substitution equivalents of Rubner.

On the other hand, if you set up "work" rations, their mechanical value must be based on their output in glucose and on the substitution equivalents of Chauveau.[2]

[1] Indeed, we shall see that a so-called "repose" ration practically represents a heat ration, the mechanical energy expended by man in ordinary business life remaining insignificant.

[2] To deal with the matter fully, mention should here be made of the energy of physiological work. This inevitable work is that which ensures the functioning of heart, stomach, intestines and lungs; in a word, of all the essential internal organs. As I have shown, the combustible of this internal work is again glucose. (For details on physiological energy see *Traité de Chaleur animale et Bioénergétique*, by J. Lefèvre, Paris, Masson, 1911, pp. 906 to 917.)

Finally, the more general problem of energy in work requires that we determine for each food species the share or proportion of its total energy in heat and movement. The solution of this problem demands the simultaneous use of Rubner's and Chauveau's numbers.

Take fat, for instance. The total energy of 100 grammes (calculated on the coefficient of Rubner) is 934 calories. The complete transformation of this fat takes place in two stages: (1) Transformation into 161 grammes of glucose (calculated on the equivalents of Chauveau), without muscular intervention, releasing 330 calories; (2) muscular combustion of the 161 grammes of glucose, the energy of which, equivalent to 604 calories, is, to the extent of one-third, distributed into 202 calories for work, and, to the extent of two-thirds, into 402 calories for heat. Altogether the energy of 100 grammes of fat, consumed for work, supplies, in two stages, 330 and 402, i.e., 732 calories in heat, and gives, in movement, the equivalent of 202 calories, i.e., a work of 85,850 kilogrammetres.

The following table sets forth in detail, for each food species (1) its thermic energy at rest; (2) its

Foods (100 grammes)	Energy at rest (thermic value)	Yield in glucose	Proportion of energy in work.			
			in heat	in force reckoned		Total
				in calories	in kilogrammetres	
Fat ...	934 c.	161 gr.	732 c.	202 c.	85·850	934 c.
Albumen...	420 ,,	80 ,,	320 ,,	100 ,,	42·500	420 ,,
Starch ...	420 ,,	110 ,,	283 ,,	137 ,,	58·225	420 ,,
Cane sugar	396 ,,	105 ,,	265 ,,	131 ,,	55·675	396 ,,
Glucose ...	375 ,,	100 ,,	250 ,,	125 ,,	53·125	375 ,,

yield in glucose; (3) the proportion of its total energy, in heat and force, in muscular work.[1]

In a second table I point out—still dealing with work—the fraction of total energy which passes into mechanical work and that which is transformed into heat. I also indicate the practical and effective yield of foods in force, in the living motor.[2]

Foods	Fraction of total energy transformed		Effective work supplied by 100 grammes of substance
	into work	into heat	
Fat	0·216	0·784	51·000 kilogrammetres
Albumen ...	0·238	0·702	25·500 ,,
Starch	0·326	0·674	35·000 ,,
Cane sugar ...	0·333	0·667	33·500 ,,
Glucose... ...	0·333	0·667	31·900 ,,

It clearly follows from these two tables, as might have been expected, that the best yield in work belongs to hydrates of carbon, and the best yield in heat belongs to fats.

We also see, from the first table, that albumen supplies far less mechanical work than the other matters, and that fat is higher than the hydrates of carbon only after a process of digestive and nutritive transformation, always more or less laborious, and under conditions of appetency and tolerance in regard to which the hydrates of carbon, and especially glucose, offer a remarkable superiority.

Indeed, it would be well clearly to understand that the isoglucosic and isothermic weights which define the energetic, caloric or mechanical relations

[1] Manifestly the figures of the total energy in work are equal to those of the caloric energy in rest.

[2] Calculation made by accepting $\frac{1}{5}$ of the glucose energy transformed into effective work.

between foods are very far from representing their physiological and practical equivalence as regards the restoration both of heat and of strength.

Purely quantitative equivalence by no means ensures a qualitative equivalence of substitutions; it ensures between equivalent food potentials neither the equal facility of penetration or transformation, nor the equal rapidity of restoring reserves or utilizing energy. Now these qualitative differences are so serious that they inevitably come first in the minds of those who consider the practical side of rationing. Consequently we will conclude this section by remarking once again that sugar, which demands no transformation or digestive work of any kind, is immediately soluble, and spreads almost instantaneously throughout the whole body—is and remains, apart from all question of equivalence or quantitative yield, the incomparable prototype of the food potential, both as regards the easy and rapid maintenance of the caloric forces and the repair of the mechanical forces of the body.[1]

VII.

On the Thermic Rôle of the Maintenance Ration. The Use of Food Energy at Rest. Intellectual Work from the Thermodynamic Point of View.

To give this teaching its full importance and practical value and at the same time to avoid all ambiguity, I must once again insist on the fact that the maintenance ration, the one that is usually consumed, scarcely represents, from the energy point

[1] We must not forget that not only the muscles, but all the parts of the body, permeated with blood, live in a sugared solution (one or two thousandths) which is absolutely indispensable to them.

of view, more than a heat ration, and that we have no reason whatsoever to demand of it any special force for our own work. Physiological instruction clearly points to the use of energy of a maintenance ration of 2,500 calories in a day's work at an average temperature, in the case of a man wearing ordinary dress and weighing from 65 to 70 kilogrammes :—

Heat radiated by the skin[1]	1,700	calories
,, lost by evaporation of perspiration ...	370	,,
,, lost by pulmonary evaporation... ...	190	,,
,, lost by the heating of the air inhaled ...	80	,,
,, lost by the heating of food	45	,,
Total heat expended	2,385[2]	calories

Thus almost the entire energy of our ration helps us to resist cold and to maintain the temperature of the body at 37° C. There are left us only 115 calories for work. All the same, this figure is amply sufficient. Indeed, subtracting 30 calories expended in the many unconscious movements about the house, we still have 85 calories, i.e., energy superior to 35,000 kilogrammetres. This energy will enable us to negotiate safely the 7 or 8 kilometres required for the various commissions of a well-filled business life ! . . .

Let us not talk, then, of strength which we have to find, nor require from our daily ration a mechanical power which it cannot give us ; above all, let us not confuse the nervous excitation we so often seek in food for the real energy which our food ought to supply.

In a word, there is no mechanical force, strictly so called, to be found in food, when we are dealing

[1] Per kilogramme and per hour, the average loss to man given by all the authorities is, in calories, from 0·5 to 0·6.

[2] See A. Gautier, *Chimie Biologique*, Paris, Masson.

neither with long excursions, nor with military manœuvres, nor with sustained work.

I again state, however, that the daily ration of 2,500 calories—the true thermic ration for the average season, will soon become, during the three or four summer months, quite sufficient to supply in addition an appreciable work ration—i.e., to give not only heat and the little strength needed in ordinary life, but also the proper energy for moderate sports and walks in the holiday season. On the other hand, in winter this ration of 2,500 calories may be found too small to meet our caloric needs, and will occasionally necessitate an extra thermic ration.

A few words may here be said of the energy expended in intellectual work. Whatever prejudice may be found amongst students in this connection, I must certainly affirm once more that this energy is extremely small—so insignificant, indeed, that it does not lend itself to strictly caloric measurement, even by instruments so sensitive and exact as that of Atwater[1]. This can readily be understood, for, however lofty the workings of thought, the cerebral activity, being localized in a few cells, cannot influence the material and energetic exchanges to any appreciable extent. The result is that mental work, when carried on to excess, may seriously injure the noblest elements of our organism and even leave us prostrate; all the same, it will have scarcely touched the thermodynamic domain, and will involve only an insignificant expenditure of energy! . . .

To those who, victims of an error that is still far too widespread, feel themselves obliged to consume

[1] Atwater: "Experiments on the Metabolism of Matter and Energy in the Human Body." *Memoirs of the National Academy of Science*, vol. vii, Washington, 1902.

strong food to help them to carry through their intellectual work, I would recommend a careful consideration of the last few lines.

VIII.

Alcohol as a Food—Critical Examination of the New Theories regarding Alcohol.

Our investigation into the energy value of food species cannot remain alien to the famous discussions that have always existed, and still exist, on the subject of alcohol. Is alcohol, or is it not, a food? A clear and decisive answer must be given to this question.

Professor Duclaux[1], basing his remarks on the experiments and conclusions of the two American scientists, Atwater and Benedict, has publicly, and as it were officially, affirmed that *alcohol is really a food.*

What are we to think of this affirmation? Is it indeed the correct expression of an indisputable experimental fact? Can it be justified by the definitions and fundamental principles of nutritive physiology? Such are the questions we have to answer.

First, let us look at this famous new fact invoked by Duclaux.

Investigations into chemical calorimetry have informed us that the combustion of 1 gramme of ethylic alcohol releases 7 calories. All the same, most physiologists still hesitate to state that the same phenomenon of combustion takes place in the body of living beings, and that alcohol accompanying a food ration is capable of supplying the

[1] Duclaux: *Annales de l'Institut Pasteur*, 1902 and 1903.

organism with the energy it releases when burning in our lamps.

Now, here we have the physiologist Atwater affirming that the combustion of alcohol really takes place in living bodies. This is a grave affirmation : the character of the author, the perfection of his apparatus, and the rigidity of his method, all alike give the assertion great authority.

The respiration calorimeter, set up some years ago by Atwater and Rosa,[1] is a splendid apparatus, in which a man can easily live for several days. Imagine a sort of room containing bed, table, chairs, instruments for physical and mental work; and yet ingeniously arranged so as to remain at a fixed temperature and faithfully register the entire heat produced by the person living in it.

Now if in this person's maintenance ration we substitute for certain foods their isothermic (isodynamic) equivalent of alcohol, the quantity of heat registered by the calorimeter is not modified by the substitution. Hence the idea that alcohol releases in the body the same heat as when burning freely! . . .

Now, let us carefully follow out the logical order of this reasoning and see whether the calorimetric discovery of Atwater and Benedict[2] really justifies the food rôle attributed to alcohol by the authorities and affirmed by Professor Duclaux.

How can a substance be alimentary? It must first be capable of serving as a reserve, by which I mean that when introduced into the body it will be stored away and remain at the disposal of the

[1] W. O. Atwater and E. B. Rosa: "A New Respiration Calorimeter, and Experiments on the Conservation of Energy in the Human Body." *The Physical Review*, September and October, 1899.

[2] After Rosa, Atwater's collaborator was Benedict.

organism which will use it according to the intensity of its needs.

We have also been taught that reserve food—and, indeed, food in general—answers three essential objects: the repair of matter, the production of heat, and the production of force. We will explain and classify these three processes:—

(1) Whether nitrogenous or mineral, the reserve is essentially plastic, i.e., restorative of organic wear and tear and of the power of nutrition (vital metabolism); incidentally, the nitrogenous reserve may still be thermic at rest, motor and thermic at work (according to the conditions stated in the preceding section).

(2) Neither nitrogenous nor mineral, the reserve is thermic for the body at rest, i.e., it restores the heat lost in proportion to its isodynamic equivalent (coefficient of Rubner).

(3) Lastly, neither nitrogenous nor mineral, and for the body in motion, the reserve is essentially motor, incidentally thermic as a consequence of muscular effort, and restorative of the forces expended in proportion to its glucosic equivalent (equivalent of Chauveau).

To sum up, a non-nitrogenous substance is motor only if it is capable of supplying glucose; otherwise, it will be thermic only. In addition, it will possess the quality of a motor or thermic diet only if it holds itself in reserve to be utilized at the right time.

Such is the precise information we should apply when dealing with alcohol.

Alcohol is not nitrogenous; it can therefore serve only for restoring energy. Can it? Gréhant[1] informs us that, after ingestion, it is found *in its*

[1] Gréhant, *Soc. de Biologie*, 1903.

natural state both in the blood and in the tissues. *It does not become transformed into glucose; therefore it is not motor.*[1]

If it is incapable of restoring strength, can it become a heat-producing food?

Assuredly alcohol may find a place in our ration without the production of heat being thereby diminished. Atwater and Benedict formally prove this.

Standard physiology, however, teaches us, not less formally, that an organism in a state of total or partial inanition always produces the same amount of heat as when it was normally fed owing to the combustion of its own reserves which supplies the heat necessary for its life. This is the physiological law of energetic equilibrium founded not on the nature

[1] We should note, however, these two facts:—

(1) Mazé has shown (*Annals of the Pasteur Institute*) in the germination of oil-seeds, that the reserve of fat is decomposed into *alcohol*, by oxidization; in again becoming oxidized, this alcohol is transformed into *aldehyde*, a body analogous to the alcohols and toxic as they are; finally six molecules of aldehyde gathered together (polymerization) form the *hexoses*, i.e., the sugars and starches necessary for the development of the young plant.

It would be interesting to know if the synthesis of sugar at the expense of alcohol, brought about by the seeds, is also possible with animals. Gréhant's experiments are not favourable to this hypothesis.

(2) It is known that all living beings are capable of producing alcohol. More than this, they all produce it normally, by means of a *diastase*. Now, diastatic actions are reversible, i.e., the same diastase, according to the conditions of the medium, is capable of combining what it has decomposed or of decomposing what it has combined. Poittevin, who clearly proved this remarkable fact (*Acad. des Sciences*, 1903 and 1904) concludes therefrom that since there normally exists in all living tissues a diastase which decomposes sugar into alcohol, this same diastase must also synthesize the alcohol ingested into glucose

or amount of the ration but on the real energy needs of bodies.

Consequently, Atwater's tests teach us, not that the alcohol ingested burns in the body, but only that it does not hinder—if administered in small doses—the fundamental law of energetic equilibrium from working.

Again, far from being kept in reserve under the discipline of the function-regulating nervous system, alcohol, according to the investigations of R. Dubois,[1] acts immediately on the tissues and cells, especially on the nerve cells,[2] first to increase their activity and afterwards to diminish it.[3]

And so alcohol permeates the body only for the purpose of overthrowing its mechanism. Without either motive or need, it causes true food to be burnt up. If it is partially consumed in its turn—a matter by no means certain—this in any case is only when the overwrought organism cools down, and that without affording any compensation for this cooling process.

Will it now be claimed that alcohol is a food?

In conclusion, we have an interesting experiment by Stammreich who supplements with alcohol an inadequate diet ration and discovers that there results an increase of the nitrogenous excretion: signifying that not only has alcohol failed to replace a

[1] Raphael Dubois, *Dictionnaire de physiologie* by Ch. Richet, Articles *Alcools* and *Alcoolisme.*

[2] The nervous system, which alcohol attacks, is the great ruler which ought to regulate and co-ordinate the whole body. Is not this the reverse of the normal order of things? And is not alcohol, in a way, the very opposite of a food?

[3] It thus excites to no purpose the combustion of the body's reserves—without in any way contributing to this waste of heat; then it lessens it. The result is that the average production of heat is not modified, as Atwater shows.

combustible aliment in the ration but it has even brought about the destruction of the tissues and of the living flesh itself.[1]

Thus we conclude once again that alcohol is not a food; we will even add that it plays a part which is the direct opposite of a food.[2]

Is there any need to sketch here the toxicological history of this dangerous poison? Suffice it to state that in reality it is neither motor nor thermogenetic, and that, above all, it deranges the nutritive mechanism; therefore physiology alone implacably condems its use, alike in a "repose" ration and in one of force or of heat! . . .

IX.

Real Energy Value of the Various Foods in Work.—Search for the Diet Regime appropriate to the Work of the Human Motor.

It is time to start investigating the energy of the various foods and of the regimes in which they appear. We can now do this thoroughly in the

[1] The fact that alcoholism (the slow intoxication by alcohol) at times produces obesity, is but the visible expression of a nutritive slowing-down process of which it becomes the cause. And everyone knows that obesity is a sign of degeneracy.

[2] In vain, with Richet, do we regard alcohol, and the sense of unnatural heat it occasions, as an accessory combustible, under the pretext that it is thus able to rouse the chilled or worn-out organism . . . This is a grave and a dangerous mistake, for excitation is rapidly followed by depression, and this depression will be all the more disastrous in that it will affect organs and reserves more than ever exhausted by the original excitation.

The entire critical *exposé* of this serious question will be found in my *Traité de Bioénergétique* (Book 4, Section 2, Ch. 8; *L'alcool et les Biothermogènes*, *Essai critique sur la valeur de l'alcool comme potentiel alimentaire*, pages 936 to 950). Paris, Masson, 1911.

light of the information contained in the foregoing sections, for we know positively that the practical motor value of any food is based on the abundant and easy production of the glucose combustible.

Nitrogenous foods, albumen and meat supply glucose only after a prolonged and laborious hepatic elaboration, which terminates only ten or twelve hours after their ingestion. Thus transformed, 100 grammes of albumen yield scarcely more than 80 grammes of glucose, i.e., a muscular energy of 360 to 370 calories. At the same time there appears a residue of 25 grammes of urea and nitrogenous excreta which are more or less toxic. This results in tardy and indifferent energy, overtaxing of the digestive organs and the liver, production of harmful residues. This is more than sufficient to condemn the use of albumen in the work ration.

Food fats can supply glucose only very indirectly. After prolonged digestion, they are poured into the blood which carries them towards the common adipose[1] reserves of the organism. When the animal works, if the hepatic glycogen becomes exhausted, the fats transfer themselves from the adipose reservoir to the liver, which uses them to make up for the sugar consumed. Thus, very tardily, 100 grammes of fat give 150 grammes of sugar, i.e., a muscular potential of 600 calories. We are also indebted to Chauveau for the demonstration of this indirect and somewhat remote part played by the fats in work, and with him we conclude that the food fat which requires a somewhat laborious hepatic and digestive operation and

[1] These reserves are well known, especially by the obese who accumulate without being able to use them! The fat remains under the skin, around the intestines and the kidneys, and in the interior of the muscles which sometimes become enormous without any increase of strength.

which gives the body only a tardy mechanical power should serve only incidentally for the work ration. All the same, since it is capable of slowly restoring the hepatic glycogen, fat may advantageously be introduced into the professional work regime or into that of athletic training.

Starchy food substances such as starch are gradually transformed into assimilable sugar in the digestive canal itself. A few hours after the meal, this sugar, poured into the blood, is carried direct to the liver which stores it away or distributes it if the muscles are being exercised; 100 grammes of digested food starch thus give 110 grammes of sugar, i.e., an energy of 450 calories. Starch, which requires but a moderate digestive effort to supply the muscular combustible within a brief space of time, may contribute largely to the work ration.

Cane sugar or beetroot is rapidly transformed in the intestines. It thus supplies 105 grammes of glucose, i.e., an energy of 430 calories utilizable immediately after this digestion has taken place; it may therefore enter with great advantage into any work ration.

Food glucose, which immediately supplies an energy of 410 calories, without any digestive effort or elaboration by the liver, represents the true food for exercise and should serve as a basis for all work rations.

I do not wish to conclude this examination of food species without mentioning the important part that mineral substances should play in work. Assuredly these substances can in no way become a food potential; they contain no energy whatsoever. All the same, they are indispensable factors of mechanical activity in the animal motor. Salts really have the power to animate the human machine by endowing living matter with the faculty of bring-

ing about food transformations and of burning the vital combustible! . . . . Indeed, it is well known that digestive processes and combustion itself are the product of certain ferments called *diastases*, and also that these diastases are active only in the presence of the salts suited to their nature. Potash, soda and lime determine the operation of the main digestive juices. Iron, connected with the *red* globules, affords a generous blood the power to transfer and distribute the abundant ration of oxygen it has collected in the lungs. Finally, manganese develops the power of that extraordinary oxidation ferment—*Bertrand's oxidase*—which, spread throughout the body and especially abundant in the muscles, alone carries through all the organic combustions.

Real natural excitants[1] of the vital mechanism and the production of force, it follows that salts must assume predominating importance in every intense exercise ration, in training and professional work.

It is now easy to define physiologically the diet regime of exercise.

In the first place, one who believes in the flesh-eating regime, that which seeks in the albumen of animal flesh all the nitrogen of the maintenance ration, cannot conceive of exercise or excursions without an abundant supply of pastry, hams, sausages and cold meat. We know why this regime is an absurd one; it can supply us neither with the

[1] These excitants bear no relation to the false excitants of ordinary diet. Salts are the true drivers of the vital mechanism; consequently they must not be confused with alcohol, coffee, meat extracts, which simply cause disturbance through nervous irritability, immediately afterwards depressing the motor force and vital energy. Table salt is used too lavishly; still it is not to be treated as one of the minerals here mentioned.

immediate energy we need nor with the ration of nutritive salts calculated to develop the mechanism of life. It overworks and tires the organs of nutrition and gives us a fleeting sensation of strength only by the production of toxic excreta which are false excitants and immediately retard our activity. After such a meal, a state of somnolence, heaviness and fatigue, would more certainly jeopardize the successful end of an excursion than a fast two hours' mountain walk beneath the burning sun.

Less exclusive—since it accepts, at all events in principle, the use of fruits and vegetables—the semi-flesh-eating regime can neither satisfy our immediate need of strength, nor preserve, in the body made heavy by too much food, that freedom and alertness, that continuous sense of well-being, which exercise demands.

On the other hand, the three anti-flesh-eating regimes wholly escape this criticism. Both during work and at rest, the *vegetarian* lives on vegetables, eggs and dairy produce ; the *vegetalian* contents himself with vegetables, and the *fruitarian* eats only fruit.

Into these regimes, sugar and mineral salts enter in great abundance[1]; all these supply considerable vital potential and active material for the physiological processes ; never do they overload the body with toxic excreta. In a word, they represent the ideal regimes for exercise.

All the same, I think it will be useful to differentiate them, and to assign to each its due place in the various kinds of work.

Indeed, we must distinguish three separate cases. In the first, the body goes into training and works for

[1] Green vegetables and fruit, which contain a large amount of mineral salts, assume an important place in every diet suited to the needs of the nutritive mechanism and of the motor activity.

a progressive muscular development. In the second case, we deal with regular professional work, not the spurt; that in which we simply keep the muscles going. The third case concerns the athlete, already trained and in good form, who within a few hours must develop intense energy revealing strength and endurance.

In these three types of work there is one common characteristic. The motor is in activity; claiming a rich potential apart from all toxins, it demands a strictly anti-flesh-eating regime. The need for nitrogen, however, is not the same. During training, indeed, when the muscular bulk is developing, there is needed an extra nitrogenous ration of 30 or 40 grammes of albumen which may easily be found in the milk, eggs and highly nitrogenous vegetables of *vegetarianism*.

In the case of the developed man, who is content to maintain his muscular activity in work and sport, the daily wear and tear of the muscles will be largely compensated by an additional 15 or 20 grammes of nitrogen obtained in simple *vegetalism*.

When dealing with intense, though necessarily limited, effort, in which muscular wear and tear is momentarily negligible, during exercise there should be adopted a glucose-base sugared *fruitarian diet* to supply immediate energy without causing nutritive fatigue.

To sum up, the work ration should be essentially vegetarian for training, vegetalian for regular work, fruitarian and sugared for athletic exploits.[1]

[1] Do not forget that, as oil fruits are extremely nitrogenous, fruitarianism would appear to suit all three kinds of work. All that is needed is to increase the proportion of oils for training, to diminish it for the maintenance of regular work, and to reduce it to a minimum in athletics. There are two drawbacks, however, to this strictly fruitarian regime: it is relatively expensive and would seem to be somewhat lacking in mineral salts.

After all, each one will find in this general physiological teaching what best suits his physical mode of living. We should all endeavour to vary our work ration according to the different phases of muscular activity.

X.

Experimental and Practical Justification of Vegetarianism in Work.

The teaching of physiology is irrefutable, while its theory distinctly dictates the rational formula for an energy-producing diet. "But then," you may say, "your experimental theory is not yet good enough for me; I must have a number of striking actual facts before I make up my mind."

And indeed this desire is too legitimate for me to refuse to give it immediately full and entire satisfaction. We will begin with professional work and then proceed to sports.

I have already quoted the report of Mr. Philipps at the Vegetarian Congress of 1900. He relates the benefits of vegetarianism amongst the workers in the large iron-works controlled by Mr. Hills at Blackwall.

In Antwerp, before the war, there was a sort of charity restaurant intended for the workmen and labourers in the harbour. For a few pence they obtained a *vegetalian* meal, consisting of pea soup and a plate of potatoes.[1] This fact, mentioned by a priest who devotes himself to the work, is eloquent

[1] I may add that this Antwerp restaurant supplies every kind of food. The reason why the workers choose a vegetalian bill of fare is that they find it to be both energy-supplying and economical.

proof in favour of a vegetable regime for the most laborious work.

The report of Dr. Capell-Brook states that the Norwegian carters, who do not use meat, can easily run three or four leagues by the side of the conveyances which carry tourists.

Darwin wondered at the prodigious strength of the Chilian miners. Strictly vegetalian, they partake of figs and bread for lunch, or cooked beans for dinner, and of corn roasted on an iron plate for supper. These men carry on their shoulders blocks of ore weighing 100 kilogrammes, with which they ascend twelve times daily a vertical ladder 70 metres in length.

The soldiers of Bolivia, well-known for their hardihood, can transport luggage a distance of 10 leagues without fatigue. They live solely on maize, cocoa and water. This remarkable fact is related by the *Panama Star and Herald.*

In the Canary Islands, the captain of an American schooner saw four of his sailors vainly endeavour to raise from the deck an enormous bale of merchandise that had been brought on board by a native. The inhabitants of these islands live exclusively on vegetarian food.

The porters of Smyrna, who live on black bread, fruit and vegetables, take the place of wheeled conveyances, which are non-existent in that town. They carry on their shoulders all the goods that arrive and depart. Mr. Langdom, an American merchant, saw one of them carry a case of sugar weighing 200 kilogrammes and two bags of corn weighing 100 kilogrammes at the same time. Mr. Wood also mentions a peasant of Smyrna who carried on his back a load of over 300 kilogrammes.

At Shanghai, the dockers, who feed on rice, carry, in twos, enormous casks of wine weighing between

200 and 300 kilogrammes. These are suspended from a stout bamboo stem, each end of which is borne on the shoulder. Thus laden, they rapidly climb the steep streets of the city. For this piece of information I am indebted to Captain B. who has also frequently spoken enthusiastically of the beauty and strength of the inhabitants of Teneriffe. Their usual food consists of uncooked pastry made of water and roasted cereal flour which they call *gofio*. Most of these men, I am informed, live strictly on *gofio*; the fish they catch is sold to strangers.

I will conclude this section by summing up a report of the *Revue Anthropologique* of 1872 on the diet of the agricultural labourer in Europe. Belgians, Dutch, Irish, Scotch, Prussians, Bavarians, Saxons, Italians, Spaniards, Russians, Swiss, Turks, &c., workers of North and South, those dwelling in snow-clad lands and those in the temperate zone, live on black bread, cereals, potatoes, vegetables and dairy produce. Rarely, except on special occasions, is meat seen on their tables.

Will not these facts suffice to convince us that vegetarianism is indeed the strength-giving regime scientifically indicated in the foregoing pages?

XI.

Experimental and Practical Justification of Vegetarianism in Sport.

Sport, an exercise reserved for those who have a certain amount of leisure, is less widespread than professional work. All the same, the facts dealing with sporting vegetarianism are perhaps even more suggestive than those just mentioned.

For some years past the Vegetarian Cycling and

Athletic Club, which began the vegetarian sporting movement in 1887, has been engaged in the most extraordinary exploits. Mr. Light made a long list in a recent report of the Vegetarian Federal Union. "In England," said the *Vegetarian* of October 18, 1902, "vegetarians hold all records from 131 to 277 miles. George Olley covered 196 miles in 12 hours, beating Steele's record of 188 miles. On the way he ate wholemeal vegetarian sandwiches and drank non-alcoholic wine—very rich in glucose —which had been sent to him by the celebrated Karl Mann . . ."

The North London Cycling Club offered gold medals to those who rode from Hadley to Buckden, about 97 miles, in 6¼ hours; two members of the Vegetarian Club alone succeeded. Indeed, the list of vegetarian cyclists' successes in England would seem to be endless.

Eric Newman, at the age of 15, accomplished an unpaced 100 miles in 6 hours 47 minutes; Kurt Pfleiderer, aged 14, did the same distance, paced, in 6 hours 26 minutes. Both were life-long vegetarians. The *Vegetarische Warte* reported the remarkable success of Dose, a vegetarian, in a race organized by the Leipzig Union in the autumn of 1899. Out of sixteen competitors, Dose was the first to arrive at the winning post, half an hour before the expected time.

In walking and running, the prowess of vegetarian athletes is even more astonishing. In June, 1899, the papers were full of the walking contest from Berlin to Schönholz, a distance of 112 kilometres. Eight of the twenty-five competitors were vegetarians; the first six places fell to them. The seventh to arrive was a meat-eater. The other two vegetarians, who missed their way, were unclassified. The winner was the famous Karl Mann, who walked

the entire distance in a few minutes over fourteen hours without a rest.

Now I come to the great vegetarian victory of the spring of 1902.

On May 19, the sporting club Komet had organized for Whitsuntide a walking match between Dresden and Berlin, a distance of 202 kilometres. The minimum time expected was 27½ hours; all competitors arriving within 45 hours were to be classified. Several well-known names were among the entrants, including the famous Johann Böge, a meat-eater. The vegetarians were represented by Karl Mann and several of his friends. Six vegetarians came in first, the winner again being Karl Mann, who, in spite of wind and rain and heavy roads, and without stopping, finished the 202 kilometres in 26 hours 52 minutes, beating almost every world record for the first 100 kilometres.

This extraordinary result is too instructive for us not to endeavour to learn the lesson it teaches.

Be it noted in the first place that the distance was the longest that had ever been set for a walking race without a stop. And, above all, remember that the event assumed a quasi-official scientific test; for the first time, a commission of physiologists and doctors, at State expense, was appointed to investigate the results. This commission, the president of which was Dr. Zuntz, of the Physiological Institute, followed the training of the two principal competitors, Böge and Mann, meat-eater and vegetarian, the former a professional, the latter an amateur who gave up his leisure time to practice.

On the day of the race the formidable pace set by Karl Mann seemed to discourage Böge, after the generous lunch of meat and wine of which he had just partaken. About the thirty-fifth kilometre, on hearing from cyclists that Mann had walked the

first 50 kilometres in 4 hours 58 minutes, Böge gave in. Mann consumed only food of immediate combustion : sweet fruit, cereals dextrinized by cooking, a little walnut butter, fresh green vegetables, raw salads, bread, and finally unfermented (non-alcoholic) wine, which is no more than a rich solution of glucose.

It is scarcely possible to imagine a ration better adapted for such an effort : one essentially based on the use of glucose, that immediate combustible for moving muscles. The dextrin of cereals, also very assimilable, aids in the rapid regeneration of the potential expended. The starch of the bread and the fat of the walnut butter find a part to play towards the end of the test in repairing reserves ; these, moreover, are consumed in moderation so as not to overload the organism with too complicated a task of nutrition. Finally, the mineral matter contained in fruits, in green vegetables and salads, when absorbed in small successive doses, ensures strength and activity in the digestive and oxidizing ferments. Thus was released in a regular stream such an enormous amount of energy as enabled Karl Mann to produce, without exhaustion, a million kilogrammetres in 26 hours.

By means of this well combined ration, Mann finished 112 kilometres 500 metres in 12 hours 59 minutes, thus beating his own record made in 1898 by 1 hour 12 minutes. From that point, certain of victory, he slightly husbanded his strength and reached Berlin two hours ahead of the next man. After responding in a lively speech to the congratulations showered upon him, he submitted for half an hour to the investigations of physiologists, amazed that a simple vegetarian had been enabled to develop such a degree of strength and

endurance, without even having had recourse to milk and eggs[1]

May I be permitted to remark to what extent the sporting life of Mann justifies the physiological teaching above indicated as regards the use of the three forms of vegetarianism.

At the outset of his training, some years previously, Karl Mann was a vegetarian, eating not only vegetables but also milk and eggs. Since completing his muscular training, he retained his strength and muscular development by means of simple *vegetalism* (without milk and eggs). Finally, he adopted a sugared fruitarianism when he had an intense athletic effort to make. Could there be more perfect agreement between theory and practice ?

In France, the exploits of vegetarianism have begun to manifest themselves.

The group of vegetarian cycling tourists of Saint-Etienne, under the leadership of M. de Vivie, have accomplished some wonderful feats, enumerated in *Le Cycliste*, the organ of the association. "On the road," says M. de Vivie, "we are all strict vegetarians (some of us are non-flesh-eaters the year round) ; for experience quickly proved to the most hardened meat-eaters that fruits, vegetables, bread and water alone could bring them into and keep them in such a condition of body as to perform successfully the work we undertake. . . ." This work is really amazing, for in a single day they cover a distance of 300 kilometres in country that ascends 2,500 metres. "Why should we be blamed" ? adds M. de Vivie. "We do not get tired, we are

[1] Most physiologists at present recognize vegetarianism : the evidence in its favour is too strong to be ignored ! All the same, up to the time of this Berlin race they had regarded it as possible only when accompanied with a large ration of milk, eggs and pulses.

anything but exhausted on our return . . . as we used to be after riding 150 kilometres. . . . Bread, fruit and water (both internally and externally as much as you please); this is what we offer any of our friends who feel disposed to imitate us."[1] Such indeed is the regime which enabled de Vivie, during his leisure hours, to ride from Saint-Etienne, in a single stage, either to Marseilles or to Chamonix, according as he preferred the sea breezes or the pure mountain air.

In concluding this section, may I be permitted briefly to relate some of my most difficult ascents in the Pyrenees? "It is at the foot of the Pyrenees," said M. de Vivie, "that we come to realize how much strength and endurance there is in a normally fed human motor." This we shall now prove.

I have practised the milk-vegetable diet ever since 1894. In September, 1901, after three weeks mountain training with a vigorous native of Argelès—quite accustomed to mountaineering but himself a semi-flesh-eater—we talked of going from Argelès to Barèges along the Lac Bleu and the Pic du Midi. It was madness. All the same, we left Argelès on September 19, about 4 o'clock in the morning, so as to take advantage of the morning freshness. Whereas my companion brought with him a supply of cold meat and *charcuterie*, I took simply a kilogramme of fresh grapes, some pears, a little cheese, black bread and a few pieces of sugar. For drink, we relied on pure mountain water. On an ordnance map showing the valleys of Argelès, Villelongue and Barèges, it is possible to follow the windings of this journey to the summits of the lofty peaks from which descend each winter the famous avalanches

[1] Article: *Sur le terrain: Bulletin du Touring Club*, May, 1901.

that have long made the valley of the Bastan a wilderness. There is no path at all, not even a mule track. Consequently, with the help of the pike, one has to undertake a difficult and painful climb through the jumble of rocks and all the unexpected incidents of mountaineering.

At eight in the morning, we had reached the summit, 2,000 metres high, which separates the valleys of Argelès and Gazost, having now traversed over 20 kilometres. The pass of Moulata led us to the lake of Isaby, and to the pass of Barané which overlooks the fine valley of Esponne in the direction of Bagnères-de-Bigorre. From there we descended to the Lac d'Ouret (the green lake), and were confronted by a gigantic wall, 1,200 metres high, which seemed to prevent our reaching the Lac Bleu on the other side. It was 10 o'clock when we undertook this third ascent; we had been walking six hours and the sun was now very hot. On reaching the middle of the slope, my companion, exhausted by the colossal effort required, wished to abandon the trip. It was too late to draw back, however, and after a little encouragement on my part, he decided to continue and to share my modest food. An hour later we reached the snowy crest which overhangs the Lac Bleu, and after a descent of 700 metres, we took our frugal lunch on the banks of the lake.

From noon to 5 o'clock, we crossed three more passes. On the crest of the Pênes Blanques, we were enveloped by fog, which is a particularly redoubtable enemy on these wild ridges so far away from all shelter; a rapid descent, however, removed the danger, and enabled us, after mounting the Aoube pass, to regain the mountain side track leading to Barèges. Two hours later, after an accelerated descent of 2,000 metres, through the chaos of rocks and vertical mountain slopes, we

came to Barèges and Luz-Saint-Sauveur, where we took train to Argelès.

During this fifteen hours' day we had, in six successive ascents, reached a height of 4,870 metres, higher than Mont Blanc, and to return to the starting point we had made a descent of an equal distance. Our horizontal tract covered 18 leagues, and the work effected by each of us reached 880,000 kilogrammetres, only 100,000 below that accomplished by Mann in 26 hours. This figure represents the daily work of three or four robust labourers.

On our return, my companion, utterly exhausted, had no thought of heaping ridicule on the vegetarian. A sleepless, fever-tossed night was unable to procure for him the rest he sorely needed. He recovered but slowly, and three months afterwards still felt the effects of the terrible strain.

As for myself, returning quite alert and showing no sign of fatigue, after a good supper and a pleasant musical evening *en famille*, I slept soundly for a few hours. I was up early next morning, when I engaged in further walks and climbs.

In 1905, within a few weeks I walked 700 kilometres, with ascents totalling 24,000 metres; in 1909, 800 kilometres, including ascents mounting to 30,000 metres.

Again, in 1912, my two sons—then aged 15 and 17, both of them being subsequently wounded in the war—and myself, within a few weeks walked 1,200 kilometres, with ascents of 33,500 metres.[1]

In September, 1916, in spite of my age, I beat all my previous records in endurance, effecting in a five hours' walk—from 8.10 a.m. to 1.10 p.m.—in

[1] The vegetarian regime they have adopted without a break from birth is thus seen to have favoured their development and their capacity for resisting fatigue.

tropical heat, a distance of 35 kilometres, with an ascent of 2,000 metres. I was back again at 6.15 p.m., having traversed 67 kilometres. I did not even change my footwear but immediately attended to various trifling domestic affairs, letter-writing, tradesmen's orders, &c., until the dinner hour.

During the month of August, 1917, my third son, aged 17, accompanied me on a walking tour over mountainous country, a distance of 920 kilometres, with ascents totalling 31,000 metres.

During the season of 1918, his younger brother of 12 walked over 800 kilometres with ascents of 30,000 metres, including a trip to the Pic du Midi —52 kilometres there and back, in 10 hours, and another to the Lac Bleu (70 kilometres and 3,000 metres of ascent) in 14 hours.[1]

What we have done, many others can do. At the age of 20, Mann, because of his weak constitution, was given up by the doctors. Twenty-five years ago de Vivie was a victim of arthritism. Close on his 50th year, he tired out the strongest cyclists of 30 years. As for myself, I should never have dared, thirty years ago, to undertake what I can now do at the age of 55.

Such good results are essentially due to the regime ; the reader understands this, and I feel certain he will not forget it.

Appended by the translator.

[Mr. Henry Light (for twenty years Captain of the Vegetarian Cycling and Athletic Club) has kindly given me permission to quote from his very inter-

[1] In 1902, my two eldest daughters—aged 19 and 18 years—accompanied by three of their brothers—aged 14, 12 and 9 years —accompanied me in a day's walk of 60 kilometres, with ascents of 2,000 metres, continuing to play and run about after their return. They are all life-long vegetarians.

esting and instructive pamphlet on "Vegetarian Athletics" (to be obtained for 3d. from the Vegetarian Society, 39, Wilmslow Road, Rusholme, Manchester), and so to bring these records up to date.

Running.

E. R. Voigt, in 1908, won the 5 miles Olympic Championship in 25 min. $11\frac{1}{5}$ sec., the 4 mile Championship of England in 1908 and 1909, and the 1 mile Championship in 1910, all open to the world.

W. Kolehmainen in 1912 won the Professional Marathon Race of 26 miles 385 yards in the World's Record time of 2 hr. 29 min. $39\frac{1}{5}$ sec. He also holds World's Records for 25 and 26 miles.

Walking.

George Allen, in 1908, broke and holds the Land's End to John o' Groats Record, covering the 840 miles in 13 days 23 hr. (exclusive of Sundays), averaging 60 miles per day. Before becoming a vegetarian he was an epileptic.

S. Norwood (aged 66) walked 100 miles in a 24-hours open path event in London.

Cycling.

F. H. Grubb broke the following unpaced out and home World's Road Records: 50 miles in 2 hr. 18 min. 31 sec.; 100 miles in 4 hr. 43 min. 33 sec.; and $220\frac{1}{2}$ miles in 12 hr. He also holds the London to Brighton and back record of $104\frac{3}{4}$ miles in 5 hr. 9 min. 41 sec., the most prized and hottest contested road record in the kingdom.

G. A. Olley won Tandem-paced Path Records from 6 hr. to 12 hr. (154 to 277 miles). Also the 1 mile and the $\frac{3}{4}$ mile Unpaced Path Records

(standing start) in 2 min. $7\frac{4}{5}$ sec., and 1 min. $34\frac{1}{5}$ sec. respectively.

C. F. Davey in 1919 won the Bath Road Club's 100 mile Open Race, and the Anerley Club's 12 hours Open Race against England's best. He also holds the London to Worthing and Back Record, and has ridden 50 and 100 miles unpaced, on out and home road courses, in 2 hr. 20 min. 7 sec., and 4 hr. 52 min. 35 sec. respectively.

Tennis.

Eustace Miles won the English Championship ten times and the Gold Medal eight times.

The Hon. Neville Lytton won the English Championship in 1911 and 1913.

Boxing.

F. Welsh won the World's Light-Weight Championship. (Welsh practises strict vegetarianism only when in training and desirous of attaining his highest form—a fact full of significance).

Wrestling.

S. V. Bacon holds the Catch-as-Catch-Can Middle-Weight Championship. In 1911 he won the Light-Weight, Middle-Weight and Inter-Empire Championships; also the Græco-Roman Light-Weight Championship.

E. H. Bacon holds the Light-Weight Græco-Roman Championship.

E. A. Bacon holds the Light-Weight Championship (Cumberland and Westminster style); two younger brothers taking second and third place.

Weight Lifting.

W. Harwood is the Heavy-Weight-Lifting Champion of the North of England, and one of but three

Englishmen who have lifted over 300 lb. (His own weight is 168 lb.)

Swimming.

Kenneth Wilson, a life-vegetarian, in 1920, aged 16 years 1 month, won the Mile Championship of Yorkshire by 80 yards, in 25 min. 59 sec., using the crawl stroke throughout, which only one other swimmer has ever succeeded in doing for a full mile.

Mountain Climbing.

Eustace Thomas (aged 51) broke the Mountain Climbing Record for the Fell District in 21 hrs. 25 mins. Map distance 56 miles, actual distance 60 miles. Height climbed: 23,500 ft. After failing in a previous attempt by as much as 6½ hr., he adopted vegetarian dietary preparatory for and during the latter attempt, and then broke the record by 42 min.].

CHAPTER VI.

ANIMAL HEAT AND A COLD-RESISTANCE REGIME.

I.

THE human body is an admirable transformer of energy, I have demonstrated its value as a motor. It is known to give a mechanical yield superior to that of the best industrial machines if care be taken to supply it with a regime suited to its needs and its nature.

This motor force, the most evident manifestation of energy, is generally regarded as the measure of vital intensity.

Quite as important and perhaps as expressive from the standpoint of nutritive vigour, the amount of caloric energy constantly reveals the powerful vital reaction of an organism. Everybody knows that a man's body is warm. It possesses and retains a fixed degree of heat; this it maintains throughout the many circumstances which seem as though they must inevitably modify it. Whether enveloped in cold or heat, in polar or tropical climates, at whatever season of the year, the human body remains at an average temperature of 37° Centigrade. A lower temperature would cause a nutritive depression which would quickly prove fatal, a higher temperature would result in a feverish condition equally fatal.

Being continually subjected to the influence of an environment less warm than itself, the body ever resists the cooling process which threatens it; thus it would seem to be a kind of thermic spring, whose force, quite as much as and perhaps even better than movement, defines and measures the energetic qualities of life. We are aware that this thermic power of resistance to cold is not the same in all; with most persons in civilized life, always shivering and shaking from cold, it remains very imperfect and manifestly inadequate. The anæmic, the neurasthenic, the arthritic and the obese, the effeminate and the prematurely old, all victims of an erroneous diet and an inadequate regime, and all more or less degenerate, are continually suffering from the cold.

In this, the last chapter, it will be my object to explain the mechanism of animal heat, then to state the source from which it may be obtained, and finally to indicate the food regime most favourable to its complete development.

II.

General Remarks on Animal Heat.

Regarded according to their power to resist cold, animals may be divided into two categories: the warm and the cold. Take a frog in one hand, a swallow in the other; the former chills you, the latter warms you. Like the frog, many other animals are cold; reptiles, batrachians, shell-fish, worms, zoophytes, vary in temperature and follow almost exactly all the changes of temperature in their environment. On the other hand, birds, mammalia and man remain uniformly warm in spite of varia-

tions in the surrounding atmosphere; these are called warm-blooded, fixed-temperature or homoiothermal animals.

The latter assuredly are the most remarkable. Endowed with greater activity than the others, they represent the most perfect type of animal organization, as well as the most exact model of that faculty of resistance whereby living nature is separated from the inert world.

How does this resistance to cold come about? A theory that has long been taught by many authorities—Winternitz in Germany, Charles Richet and his pupils in France—claims that the warm-blooded animal is shielded from the cold by its thick covering, by the fur or down which envelop it to such a degree that, were it naked, its body would become cold like that of the frog. To explain the special resistance to the intense cold of winter, the same physiologists claim that the warm-blooded animal concentrates about the deep regions of the body the whole of its liquids and blood, in order to avoid losing the precious blood heat by contact with the cold environment; Richet actually affirmed that the rabbit loses three times less heat when the atmosphere is at zero than when it is at 15° C.! . . .

This paradoxical and too gratuitous hypothesis has unfortunately been too favourably received in our modern societies whose sensual instincts it flatters. Are we acquainted with many persons who attempt to resist cold by any other means than the excessive heating of their living rooms? All the same, our climates are very temperate; no one can regard them as Siberian in intensity. And yet it is in these moderate climates of ours that official hygiene recommends three blankets and an eiderdown, wadded socks and hot-water bottles in bed. It is in these climates that custom forces us to keep our

rooms at hot-house temperature. Shall we not soon be prevented from setting foot outside the house without wearing a series of furred coverings, themselves surrounded by the voluminous skin of some ruminant or other, a ridiculous fashion which the chauffeur would appear to have introduced into the world of pedestrians?

Assuredly we should never put up with such practices were we not already, more or less consciously, advocates of that passive resistance, which is extolled by most doctors. And yet, how singular a theory it is that deals with a man as though he were a plate kept on the warmer, or a bowl of water surrounded by a number of covers to prevent the heat from escaping! . . . .

It is good to contrast with this ultra-simple formula of passive resistance, this puerile physiology of animal heat, the rigorous and experimental formula of active resistance that which I have myself ardently defended for the last twenty-five years. This formula may be summed up in the three following propositions:—

(1) The normal heat of the warm-blooded animal comes wholly from itself, and results from the intensity of its combustions.

(2) The greater the cold, the greater the loss of heat experienced by the warm-blooded animal.

(3) The greater the cold, the greater the amount of heat produced by the warm-blooded animal.

In a word, the warm-blooded animal is normally constructed for warming itself by its own heat; and in a robust well-fed organism this heat is proportioned to the expenditure required by the cold.

I will not even attempt to sum up here the innumerable experiments I have made, the results of which have been published in special reviews on

physiology.[1] I confine myself to mentioning a few important facts.

In the first place, while it is true that the fur of animals partially protects them from the cold, it must not be forgotten that certain warm-blooded animals are able to dispense with it, and that the pig, with scarcely any protective covering, resists cold almost as effectively as the rest of the mammalia. Is this resistance to be attributed to the thick layer of fat in which its body is enveloped? By no means, for the blood penetrates the coat of fat and spreads all over the pink skin of this pachyderm, distributing the heat which its chilled surface continually needs. Consequently the caloric losses of the pig are enormous, though this fact does not prevent it from maintaining a temperature of over 39° Centigrade.

Consequently the presence of a fur does not explain the resisting power possessed by the warm-blooded animal. I now add that neither this fur nor any other natural arrangement could prevent such an animal from losing a certain amount of heat which rapidly increases as the cold becomes more intense. This is an experimental fact which I have proved in a considerable number of investigations made both on men and on animals.

Thus the human organism which at about 35° C. loses scarcely one calorie per minute, loses seven in water at 18° and nineteen in water at 5°. This means that the adult man loses eighteen to twenty

[1] My articles sum up several thousands of experiments, the results of which have for twenty years formed the subject of thirty memoranda in the *Archives de Physiologie* and in Bouchard's *Journal de Physiologie et de Pathologie générale.* The methodical study of the conclusions will be found in my treatise on *La Chaleur animale et la Bioénergétique.* J. Lefèvre, Paris, Masson, 1911.

times more heat in frozen water than in tepid water. The same thing takes place, not only in the pig, but also in the ape and the dog, even in certain animals with fur or compact plumage, such as rabbits and guinea-pigs, ducks and hens.

I have also proved that a moderately clothed man, standing in a draught, loses three or four times more heat at 5° C. than at 20° C.

Finally, in an absolutely calm atmosphere, the expenditure of heat from a rabbit or a duck is five times as great when the animal passes from ordinary summer temperatures to average winter temperatures. All the same, the temperature of the body does not change.

The conclusion to be drawn is evident and cannot be disputed. The normal warm-blooded animal keeps warm, not by the heat it receives or stores away but by the heat it produces. In a word, the living organism is and must remain a powerful generator of heat.

The amount of this production is sometimes amazing in a strong and well-exercised organism. Here is an instance. I take my temperature which records 37·4° C. and plunge into a cold bath of 4° C. In ten minutes I have lost nearly 400 calories; so that if the theory of passive resistance were true, my body ought to have chilled down to about 32° C. As a matter of fact, on leaving the bath, it is 37·5° C. That is to say, during this formidable refrigerating process, I have supplied, in ten minutes, the 400 extra calories which have kept my temperature practically as it was at the start. Only the skin is slightly chilled, and yet even this, in the bath itself, gives a temperature of over 20° C.! . . .

Hundreds of similar experiments have been made on various persons and on warm-blooded animals. On each occasion there has been clearly revealed

the existence of a powerful heat-producing energy, Still, we must not draw exaggerated conclusions from these experiments, conclusions which they do not warrant. Let there be no misunderstanding; I am not proposing that man should be in a semi-nude condition, protected by the powerful calorification of his interior tissues. Neither morality nor hygiene could accommodate itself to such a regime. It has simply been my object to destroy the old prejudice whereby we endeavour to find the source of animal heat and resistance to cold in external heating or hermetically shutting ourselves up in a room with chinks stopped and windows closed. In a word, I wished to prove to demonstration that the normal warm-blooded organism is a veritable calorifère of remarkable intensity. This proof has been made, it cannot be refuted, so I have nothing further to say on this point.

III.

The Mechanism of the Production of Heat in the Organism at Rest and at Work.

The warm-blooded organism produces its own heat; it produces it in proportion to the needs of thermic regulation for maintaining its temperature. We shall now see what is the mechanism of this production.

Heat is one form of energy. The source of vital heat therefore, like all energy, is found in the chemical potential, i.e., in the foods which the animal consumes. As already seen, all the operations of nutritive life in the animal at rest require an incessant consumption or expenditure of energy. Borrowing from its food the chemical force it contains, the animal releases this power, transforms it into physiological and vital energy, and then throws it off in the form of heat.

This heat, produced and released by the animal, is the gauge both of the potential energy of its maintenance food ration, and of the amount of its vital strength.

We have seen that the releasing of this potential is effected by chemical combustion, i.e., by the action of respiratory oxygen. For this reason also the activity of respiration gauges the intensity of life and the thermogenetic power of the organism.

These facts contain an important suggestion which I will just make in passing.

It will be seen that the chemistry of food justifies the existence of this heat-producing force mentioned in the preceding chapter. There is heat because there is life; and where life is intense, the heat produced is equally abundant.

But this is not all. The two phenomena are mutually connected: life produces heat, and in its turn the free and active production of heat ensures the free and active manifestation of vital energy. In other words, we cannot conceive of motor activity without an appropriate release of heat produced by the organism. Is it not evident that any obstacle to the regular efflux of this heat will bring about, as a result of the natural defensive powers of the organism, the slowing down of its vital manifestations? For if this slowing down did not take place, the body would rapidly become overheated and reach a fatal temperature! . . . .

To retain organic heat, therefore, is to arrest both thermic production and life itself. On the other hand, to permit the normal efflux of this heat is to accelerate in reflex fashion[1] the thermogenetic and

[1] The reflex act is the natural and automatic phenomenon of an organism's reaction to external influences. The production of heat is indeed regulated by the expenditure, i.e., by the amount of external cold.

vital reactions; in a word, it is to obtain from the organism the tonic and vivifying action it needs.

Finally, we will also remark, though there is no need to insist on the fact, that the caloric resources of a warm-blooded animal are related to the richness in energy of the food ration, and that the choice of this ration assumes the utmost importance in the thermogenetic mechanism for resisting cold. This is a serious question to which we shall devote the second part of this chapter.

For the time being, let us note that all organic heat arises solely from food energy. We will try to discover what are the great centres of animal heat in the body.

According to the foregoing teaching, we may reply offhand, adopting the formula of Arthus: "All those tissues in which chemical reactions take place are producers of heat; and their calorific rôle is all the more important if they are the seat of more intense chemical reactions." Each tissue, therefore, contributes to the formation of the general heat of the body, and thus is an element in thermogenesis in proportion to its activity. The blood circulating through the organs equalizes and distributes the heat obtained from these different centres.

But there are certain of these organs which seem to have the almost exclusive monopoly of calorification; I refer to the glands and muscles, the remarkable thermic potency of which we shall now briefly examine.

Ludwig in Germany and Claude Bernard in France long ago demonstrated that the salivary glands are warmer during secretion than when they are at rest. It is also known that the blood which issues from the liver has a higher temperature than that which enters it.

The following is the way in which I have shown the great thermogenetic power of the liver.[1]

An animal is first chilled several degrees in a bath. By special processes well known to physiologists, its temperature is taken at various parts of the body. In this way, by following the temperatures of liver, muscles, rectum and skin, we note (whilst the animal is regaining its heat) that the liver is one of the great centres of this thermic reaction : it distributes heat and thus largely contributes to bring back the body to its normal temperature. We need not wonder at this, for we know of what activity the liver is capable.

This centre is not the only one. We find another more important still in the mass of muscular organs which, even at rest and not contracted, release a great amount of heat. This has already been seen in the well known fact that the muscle at rest consumes two or three grammes of glucose per kilogramme every hour. Moreover, experimental physiology informs us that, even when completely inactive, the muscles still produce 40 per cent. of the entire heat of the body.

These facts are evident. All the same, as in the case of the liver, I have given direct proof of the thermogenetic power of the muscles.[2]

A dog, chilled a certain number of degrees, is now at rest. As he regains his heat, we find that violent muscular thrills take place, and then we perceive, by examining temperatures, that the muscles help the liver in effecting the work of reaction.

These precise results may be summed up as follows :—

[1] J. Lefèvre : "*Sur le Mécanisme du réchauffement*," *Journal de Physiologie et de Pathologie générale*, 1898.

[2] J. Lefèvre, *loc. cit.*

In the animal at rest, muscles and liver are the two main centres of animal heat.

Now let us suppose that the organism is performing work, in other words, that it is functioning as a motor. The general activity of the organs of nutrition is greatly increased; the heart beats more energetically to distribute a greater flow of blood. Respiration increases in order to give an enlarged ration of oxygen to the augmented combustions. The glands secrete in greater quantities. The liver accelerates its transformations in order to meet the expenditure of sugar, the one essential combustible.

It is mainly to the play of the muscles in activity that is due most of the development of animal heat. We may remember what has already been said in the chapter on thermodynamics.

Glucose, produced by the liver, is distributed to the muscles. In mechanical work, the muscular energy, which is wholly obtained from this sugar, is divided into two parts :—

One-third for external work.[1]

Two-thirds for muscular heat.

It is unnecessary at this point again to justify this law, but the reader may note that the greater part of the muscular ration of work is transformed into heat, and that this heat is added to the heat already produced by the common activity of the organs of nutrition, itself being increased by work.

Thus, in the total energy of the so-called work ration, one part, which serves to increase the general nutritive activity, is wholly transformed into heat; the other—the greater—part, which serves the the muscles, increases the muscular combustible,

[1] We are aware that the practical yield of the muscular motor is less than one-third, and that it is generally reduced to one-fifth by reason of the work lost in the accessory operations of the body.

and two-thirds of this combustible supplies additional heat.

It is these two sources of heat which combine to produce the overheating of the body during exercise.

* * * * *

It does not appear necessary to prolong this physiological investigation in order to justify the following conclusions :—

(1) Warm-blooded animals maintain their temperature by means of their own thermogenesis; this production is normally sufficiently great to enable them to endure a considerable degree of cold.

(2) The thermogenetic force reveals the strength of an organism, for it gauges the exact intensity of life ;

(3) Excessive conservation of organic heat diminishes thermogenesis, retards life, and leads to a progressively enfeebled condition ;

(4) In a vigorous organism, the power of caloric production requires richness of food potential ;

(5) When the organism is at rest, liver and muscles share the work of producing animal heat ;

(6) If the organism is in motion, a great amount of heat is formed in the muscles, and these become the chief centres of thermogenesis.

(7) In any case, whether the organism is at rest or at work, whether heat is produced in liver or in muscles, glucose sugar represents the main combustible of animal heat.

In a word, glucose is not only the food of mechanical force, it is also the most valuable heat food.

We will then try to find the diet regime most suitable for the development of heat, the one which, without danger, will enable us to withstand the severe winter cold.

IV.

Climate and Diet Regime—Inadequacy of Meat as a Heat-giving Food—Thermic Value of Foods.

Were we to take a referendum of modern society with the object of discovering what it considers the regime most suitable to the development of animal heat, I am convinced that all, or almost all, whether of the lower, the middle or the upper classes, whether ignorant or learned, would enthusiastically extol the flesh-eating regime. Why is this? No one knows. And yet everyone affirms his conviction, a profound and deeply-rooted conviction, as we shall see.

About thirty years ago, I was discussing vegetarianism with a well-known Normandy doctor, correspondent of the *Institut* for the medical section of the *Académie des Sciences:* "I approve of your regime" he said, "for those who inhabit hot countries, seeing that they have no cold to resist; but I absolutely reject it in this climate of ours, where the needs of resistance to cold call for a stronger regime. The more we travel north, the more meat should be consumed; indeed, this is so manifest that those who inhabit the polar regions live exclusively on flesh, because vegetarianism would be incapable of sustaining life. By following an inevitable and almost instinctive law of adaptation, the animal which, starting from the equator, gradually advanced in the direction of the poles, would modify its regime by seeking after more and more substantial animal food. If, perchance, an attempt were made to check this necessary change, the animal would speedily become enfeebled and would quickly succumb to the severity of such a latitude . . ."

To this attack I offered two replies: the one dictated by common sense, the other by experience.

I first of all remarked that Greenlanders and Esquimaux must, of necessity, renounce all desire for vegetarianism. How could they adopt such a diet? Can you imagine the Esquimaux setting their wits to work in the cultivation of peas or beans, potatoes or carrots or turnips, lettuces or leeks, on the block of ice beneath their feet? These good people live on what they find at hand; necessity is their law. Were I in their place, equally anxious to maintain life, I should resolutely abandon all idea of vegetarianism, I should devour pounds of bear steak and drink quarts of seal oil! It is unnecessary to state that my opponent had no objection to offer against such evidence.

My second reply was more decisive; it may be summed up in the following experiment.

It is well known that the ape, a tropical animal, is strictly vegetarian, or rather, fruitarian. I once procured quite a young rhesus immediately it reached the shores of France, and methodically trained it to the open-air life of our climate. After a few months, this young ape was living night and day without shelter or covering of any kind in rain and snow, subject to severe frosts. Instead of becoming weak, the animal developed splendidly. It did not even have the slightest illness . . . did not even catch cold.

Never would it accept the smallest piece of meat, whether raw or cooked; on the contrary, it entered into a state of violent anger, thrust aside the plate and scattered in every direction the morsels we left by its side. It pounced eagerly upon the fruits and vegetables we offered it. Even starvation would not have overcome the repugnance it felt.

This fact deserves to be remembered; of itself alone it would suffice to do away with the fairy story regarding the benefit to be obtained from meat in

a cold-resistance regime. It is clear and irrefutable physiology that gives us this result.

We have no other source of heat than that which comes to us from our food. Therefore the true foods that supply animal heat are assuredly those whose combustion releases the greatest number of calories. We know what these foods are. All the same it may prove serviceable to mention them here, and to set forth the amount of energy produced by the combustion of each food.[1]

Name of Foods	Energy contained in 1,000 grammes
Dry almonds	6,000 calories
Cheese (Gruyère)	3,732 ,,
Lentils and legumes	3,725 ,,
Raisins and dry sugared fruits ...	3,510 ,,
Maize	3,610 ,,
Wheat	3,500 ,,
Rice	3,500 ,,
Bread	2,718 ,,
Egg	1,460 ,,
Lean meat	1,150 ,,
Potatoes	902 ,,
Milk	730 ,,
Fresh grapes	644 ,,
Bouillon (one pound of meat per litre)	30 ,,

To give this table its full value, the whole of its significant truth, it must be remembered that, even in work, the greater part of food energy passes into heat. The figures, therefore, in the preceding table, practically represent the thermic value of the foods. From it, we see how lacking in heat production is flesh food. It is only tenth in the list, coming after the dried fruits of winter, cheese, cereals, legumes, bread and even eggs. Almonds develop five times as much heat; cheese, legumes and cereals three times as much; dry fruit and bread twice as much.

[1] We may also refer to the tables we have drawn up for the thermic yield of food, in the previous chapter.

Lastly, we should have to eat more than 600 grammes of meat to obtain the heat contained in a single litre of milk.

Nor is this everything. The practical problem of heat, as also that of motor force, involves the important question as to how the organism is to find rapidly, in abundance, and without fatigue, digestive strain or nutritive intoxication, the combustible necessary for successfully resisting cold. This important question of practical hygiene we shall now briefly examine.

V.

Choice of a Winter Thermogenetic Regime.

We are aware that the two great centres of animal heat are the muscular and the hepatic masses. Both of these are charged with glucose, that glucose which the liver incessantly produces and which it laboriously extracts from meat. In truth, glucose is the principal, and, so to speak, the real animal combustible consumed partially in the liver but mainly in the muscles. Consequently, the best regimes for thermogenesis and resistance to cold are those which easily and rapidly supply a large amount of glucose. What are these foods and regimes? We mentioned them when dealing with the energy of the animal motor; I return to the subject the better to indicate the diet to be sought and that to be avoided in winter.

A few words, then, on each kind of food.

Albumen, more particularly the albumen of meat, sets free its potential only after laborious intervention on the part of the liver; there also appears with the urea a certain amount of nitrogenous excreta that are more or less toxic. Albumen thus supplies

heat only by overworking the digestive and hepatic organs and exposing the organism to the dangers of defective nutrition.

Fats have a heat value twice as great as that of meat; they become slowly transformed into glucose without producing any toxic residue whatsoever. They may thus advantageously form part of a cold-resisting regime. In reality it is from animal fats, not from meat itself, that the inhabitants of the polar regions obtain their heat. We may find the same source of heat in butter, cream, oils and oleaginous fruits.

Starchy substances require only a moderate digestive effort. Without producing either fatigue or intoxication, they are able to supply, along with glucose itself, a considerable amount of heat. In countries like ours, therefore, where they are to be met with in abundance, such substances should form one of the essential bases of a cold-resisting regime.

Cane sugar—common sugar—supplies glucose very rapidly, after an easy digestive transformation. If introduced in large proportions into the cold-resisting regime, it will easily and almost certainly supply the necessary heat.

Finally, glucose is found in sweet fruit. Immediately assimilated, before any digestive process takes place, it spares the liver from being overworked by glucogenic transformations and at once proceeds to the body's centres of combustion.

Glucose, therefore, is the typical food for rapid thermogenesis. In winter, honey, dry fruit, stewed fruit and preserves, and finally such fresh fruit as is in season, a light and healthy diet, will meet even exceptional cold-resisting conditions.

It is now easy to make a critical examination of the various regimes in the winter season.

We will suppose that the system has absorbed, in some form or other, the ordinary maintenance ration necessary for repairing expenditure and restoring strength. Naturally to this ration there will be added, in winter, more or less consciously, a cold-resisting ration; we assume that this extra ration has an average weight of 550 grammes, and shall now see what heat is supplied by this weight of food in the principal regimes.

In winter, a meat-eater, in addition to his maintenance ration, will absorb about 300 grammes of meat and 250 of bread. These will supply him with 1,000 extra calories, i.e., a very inadequate amount of heat, seeing that winter causes him to lose at least two or three times as much heat as does the average temperature of the other seasons.[1]

A semi-meat-eater, under the pretext that he does not know what to eat in winter, will mainly increase his meat ration and but slightly his vegetable ration; 175 grammes of meat, 75 of legumes and 200 of bread will supply him with only 150 calories, i.e., an amount of heat that is still quite inadequate.

On the other hand, with the same weight of vegetables, bread and fruit, the *vegetalian* will benefit by an extra 2,000 calories, and will find himself, though but moderately clothed, quite able to meet the heat expenditure required by wintry weather.

The fruitarian, whose diet supplement of 550 grammes would include 350 grammes of sugar, mainly obtained from sweet dry fruit, and 200 grammes of oleaginous fruit, would reach the enormous figure of 2,700 calories—i.e., a heat nearly three times as great as that obtained by the meat-eater—without digestive strain or nutritive

[1] Unless one lives in a *hothouse* or covered with thick furs, a state of things which, as I have already said, is opposed to the physiological order of life in temperate climes.

ntoxication. He would thus obtain heat sufficient to endure easily our most severe winter cold.

To sum up, non-flesh-eating regimes come first in an extra winter ration. Poor in albumen, though rich in sugared potential and in mineral substances, they may be absorbed in considerable quantities without fear of dangerous toxic fermentation or of dreaded attacks of arthritism.

VI.

How Winter becomes the Usual Season for Disease.

I do not wish to conclude this investigation without showing the reader the consequences of his winter regime.

Winter—true winter accompanied by the normal amount of cold weather—is not the unpleasant season one is so accustomed to complain of and bewail.

All the same, what do we generally do to combat its severity? Do we not expect to find in meat, and almost entirely in meat, that precious heat it is unable to give us? At all events, we sometimes double and at times treble the amount we consume; and, though we do not succeed in becoming warm, we nevertheless adopt a regime which overtaxes our nutritive mechanism, intoxicates the humours of the body, and hastens organic decay. And yet it is this excessive meat-eating in winter that deprives the organism of nutritive and life-giving salts, and, in return, calls for the constant excitation of aperitives, strong drink and brandy. Thus it is flesh-eating in winter, far more than flesh-eating in summer, that we must now condemn.

In summer, however depraved our tastes and perverted our instincts, in spite of routine and prejudice, the ordinary appetite rebels at the consumption of

generous rations of under-done flesh and inclines us to accept fruit and early vegetables. But in winter, when the appetite increases, we think we are being prudent if we employ it on a regime which is usually regarded as strengthening. And this deplorable regime, in former days counteracted by the sage precepts of the Church, is now continued right through the spring season into the early days of summer.

We know full well the consequences of a debauch of meat.

Although he may be very stout and ruddy-complexioned, a man who habitually engages in such a debauch rapidly becomes weak and chilly; his dread of cold weather knows no limits. He wraps himself in flannels and woollens, warming himself over and over again, by night and by day, and even then he remains cold to the bone and eternally suffers from cold feet. Indeed, he has become a prey to cold, the unresisting prey to all the attacks of winter.

Do I exaggerate? Certainly I do not, for you are well aware that this grave state of inertia is rapidly followed, after the excesses of winter, by the terrible effects of nutritive strain, i.e., by arthritism and intoxication.

VII.

The Practical Justification of Vegetarianism in Resistance to Cold.

Having reached the end of this work, I feel I must give a few instances proving materially the extraordinary thermogenetic vigour which may be attained by the organism of a well-trained vegetarian.

We know how strong and hard-working are the Russian and Norwegian peasants. Nor is their

power of resisting cold less remarkable, seeing that they are for several months exposed to a temperature considerably below freezing point. And yet most of them are practically unacquainted with the use of meat, living as they do principally on vegetables and black bread.

The peasants of Bavaria, Saxony and Wurtemberg, of necessity almost all vegetarians, endure the most severe winters, simply adding to their ordinary costume a common shirt made of rough cloth.

The power of resistance to cold shown by the famous fruitarian cyclist, M. de Vivie, is extraordinary. However bad the weather, he sleeps with his window wide open and very scanty covering. On excursions, he generally sleeps in his hammock, except when the weather is extremely cold or unpleasant.

I myself have found in a milk, vegetable and fruit diet a degree of thermogenetic endurance which greatly puzzles those yet unacquainted with the resources of animal heat.

In winter I do not suffer any inconvenience in going about my various occupations without an overcoat and wearing only a light summer suit. For four successive years, I have easily endured the most severe tests of cold, during the time that I was working at my theory of thermic resistance. Every day I took two baths, lasting ten or fifteen minutes, in ice-cold water, sometimes at a temperature of 2° C. or 3° C.

In the intervals, I was engaged upon my numerous professional duties, without any special covering, during the bitter cold of the winter 1894-1895.

During that winter, I long remained motionless in water at temperatures varying between 7° C. and 15° C.; I also made double-bath experiments, passing suddenly from a tepid temperature to an ice-cold one.

The two following winters I carried through calorimetric investigations in chilly draughts, remaining naked and motionless in a ventilated calorimeter, exposed during three or four hours to the shock of violent and ice-cold draughts ! . . .

I had no difficulty in withstanding all these rigorous attacks. And yet, to the 1,000 or 1,500 calories daily expended in these experiments were also added the 1,500 calories of resistance to the season's cold, in a light costume, and the energy needed for the process of nutrition. For all this, my diet proved abundantly adequate, being essentially based on fruits, vegetables and milk which are rich in energy-giving properties, and, speaking generally, on food-substances, which, while easy to digest, release a large amount of vital combustible.

My general conclusion will be the one I mentioned in the preceding chapter : what we have done, many others are capable of doing, for vegetarianism is the only regime which, without overstrain or intoxication, enables us to develop to the full extent the motor forces of our bodies and to increase their cold-resisting power.

Finally, I wish to warn you against an illusion which might discourage you in attempting to adopt this regime. I have said and proved that vegetarianism easily affords the richest and purest combustible. All the same, do not imagine that it alone will give you that muscular strength and cold-resisting power of which many remarkable instances have been stated. In addition, there must be developed the trophic (or nutritive) power of the tissues, more especially of the nervous system. This power you will obtain only by methodical training and by regular exercises for the promotion of stamina and endurance.

INDEX.

A

Abyssinians, 40
Académie de Médecine, 82
Allen, George, 162
America, 18, 65, 66
Arthus, 79, 173
Atwater, 139, 144
Australia, 20
Austria, 18

B

Bacon, E. A., 163
Bacon, E. H., 163
Bacon, S. V., 163
Bavaria, 185
Belgium, 18, 24
Benedict, 140, 141, 143
Bernard, Claude, 56, 59, 121, 125, 127, 128, 173
Bertrand, 148
Blanchard, 51
Böge, Johann, 155
Bohn, 81
Bolivia, 152
Bonnejoy, 10, 11, 21
Bossuet, 7
Bouchard, 12, 74, 84, 127, 169
Bouchardat, 84, 85

C

Canary Islands, 152
Capell-Brook, Dr., 152
Catholic Church, 6
Chauveau, 41, 121, 124, 125, 129, 133, 135, 142, 146
Chrysippus, 4
Chrysostom, 5
Church Fathers, 5
Clement of Alexandria, 5
Cuvier, 10

D

Dastre, 128
Davey, C. F., 163
Denmark, 18
Deswarte, 68
de Vivie, 157-158, 161, 185
Diderot, 7
Dieulafoy, 81, 84
Dominici, 12, 70-71, 83
Dose, 154
Dubois, 144
Duclaux, 140, 141
Dujardin-Beaumetz, 10, 12, 21, 77, 78, 84
Dukhobors, 19
Dumas, 51

E

Eck's fistula, 78, 79, 80, 82
Esquimaux, 178

F

Fick, 123
Franklin, 10

G

Gasparin, 93
Gassendi, 6, 10
Gautier, 78, 85, 93, 118, 138
Germany, 17, 18, 24
Gilbert, 70-71, 83
Gleizès, 14, 15, 20
Glénard, 74
Grand, Dr. Jules, 22
Grandeau, 109, 118, 126
Greenland, 178
Gréhant, 142
Grubb, F. H., 162

H

Harwood, W., 163
Hills, Arnold F., 16, 94, 151
Hirn, 93
Huchard, 10, 66, 81, 82, 84
Hunter, 109

I

Iamblichus, 4
Italy, 18

J

Jackson, Dr., 65 68
Joule, 117

K

Kaufmann, 124
Kellogg, 19
Kingsford, Dr. Anna, 111
Kneipp, 21
Knight, 103
Kolehmainen, 162
Kühne, 21
Kulz, 129

L

Lagrange, Dr., 76
Lahmann, 65
Lamartine, 9, 10
Lapicque, 126
Laulanié, 114, 123, 124
Lavoisier, 119, 120
Lécorché, 84
Lefèvre, J., 126, 134, 145, 169, 174
Lépine, 84
Liebig, 27, 28, 29, 88, 122, 123
Light, H., 17, 154, 161
Longinus, 4
Lucas-Championnière, 10, 12, 84
Ludwig, 173
Lytton, Hon. Neville, 163

M

MacFadden, 19
Malayans, 40
Manchester, 14, 15
Mann, Karl, 154, 155 . . . . 157, 160
Maurel, Dr., 75
Mayer, 116, 117
Mazé, 143
Michelet, 9
Miles, Eustace, 163
Milne-Edwards, 10
Mossé, 85
Muntz, 118, 126

N

Nazarenes, 3
Neo-Platonists, 4
Netherlands, 18
Newman, Eric, 16, 154
Newton, 10
Normandy, 177
Norway, 152, 184
Norwood, S., 162
Nyssens, Dr., 18, 22

O

Olley, 16, 154, 162
Ovid, 5, 10

P

Pascal, 10
Pascault, Dr., 75

Pasteur Institute, 143
Pelasgians, 3
Perfect Way in Diet, The, 111
Plato, 3, 4
Plutarch, 4
Poittevin, 143
Porphyry, 4
Portugal, 18
Pythagoras, 3, 5

R

Ray, John, 6, 10
Reiche, 10
Richet, Charles, 67, 124, 144, 145, 167
Rickli, 21
Robin, 10, 84
Rosa, 141
Rousseau, 7
Roux, J., 87
Rubner, 95, 131, 132 135
Rumford, 116
Russia, 18, 184

S

Saxony, 185
Sée, G., 84
Seneca, 4
Sextus, 4
Shanghai, 152
Shelley, 8
Smith, 120
Smyrna, 152
Stammreich, 144
Sweden, 18
Switzerland, 18

T

Teneriffe, 153
Thomas, Eustace, 164
Triptolemus, 3
Tyndall, 116

V

Van Helmont, 6
Vegetarian Cycling Club, 16, 153, 154, 161
Voigt, 162
Voit, 124
Voltaire, 7

W

Walker, 16
Welsh, F., 163
Williams, 10
Wilson, Kenneth, 164
Winternitz, 167
Wislicenius, 123
Wolff, 118, 124, 126
Wurtemberg, 185

Y

York, 15

LONDON
JOHN BALE, SONS AND DANIELSSON, LTD.
83-91, GREAT TITCHFIELD STREET, W. 1.

BINDING LIST AUG 28 1940

MPhy.
L.
196234
Author Lefèvre, Jules
Title A scientific investigation into vegetarianism.

University of Toronto
Library

DO NOT
REMOVE
THE
CARD
FROM
THIS
POCKET

Acme Library Card Pocket
Under Pat. "Ref. Index File"
Made by LIBRARY BUREAU